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SYSTEMS ENGINEERING PLAN FOR NAVY THEATER-WIDE THEATER BALLISTIC MISSILE DEFENSE (TBMD)—VOLUME I: SYSTEM REQUIREMENTS ENGINEERING

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FOREWORD

This plan for system requirements engineering defines the steps necessary to engineer Theater Ballistic Missle Defense (TBMD) Navy Theater Wide (NTW) system. The high level architectures and requirements that result from this process are intended to guide future development priorities and road maps, describe functional allocation alternatives, and define interface controls required for safe and effective deployment of TBMD NTW.

System alternatives and upgrade priorities are established by economy of force for a reference mission and time period. Cost is balanced with performance in terms of defended volume, kill probabilities, and sustainability. The tenets of life cycle cost reduction, ease of upgrade, increased force interoperability, and TAD mission area optimization govern allocation of functions.

This publication has been reviewed by Mr. E.R Whalen, Head, Warfare Systems Division.

Approved by:

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CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

Section Page

CONTENTS (Continued)

FIGURES

CONTENTS (Continued)

TABLES

GLOSSARY

NTW SYSTEM REQUIREMENTS ENGINEERING GLOSSARY

This glossary provides definitions of essential terms as used in the plan for executing NTW system requirements engineering. This glossary is an integral part of the NTW System Requirements Engineering and is to be used in the development of documentation called for in this document.

DEFINITIONS

ATTRIBUTE: NTW system characteristics which can be organized into various categories such as functions, constraints, performance parameters, cost, physical characteristics, supportability and availability.

ALLOCATED BASELINE: The approved documentation describing the NTW element's functional, performance, interoperability, and interface requirements that are allocated from those of the higher level system, NTW. The Allocated Baseline will include the interface requirements with interfacing subsystems; design constraints, derived requirements (functional and performance); and verification requirements and methods to demonstrate the achievement of those requirements and constraints. The NTW Allocated Baseline will be in the form of a System Requirements Document (SRD) for the NTW nomenclatured subsystems and will be the primary product of Step 4 of this plan. The SRDs will be the basis for the Program Manager's implementation of the nomenclatured systems.

CONCEPTUAL PERFORMANCE BASELINE (CPB): The documentation that identifies the NTW performance concept chosen to meet the needs identified in the top level operational requirements documents. The Conceptual Performance Baseline includes broad objectives and thresholds for key cost, schedule and performance parameters, including supportability. Objectives will include thresholds identifying minimum acceptable requirements. The initial CPB will be the primary product of Step 3 of the system requirements engineering process described in this plan. Reevaluation of alternative concepts or approaches will be performed if Step 4 of this plan determines that key parameters are not met.

CONCEPTUAL PERFORMANCE BASELINE REVIEW (CPBR): The formal review of the results of Step 3 of the NTW system requirements engineering process.

CONCEPT OF OPERATIONS (CONOPs): A document that addresses the operational employment of a system(s).

DESIGN REFERENCE MISSION (DRM): A detailed description of the operational environment within which the NTW system attributes and requirement allocations are evaluated and are used to evaluate the relative merit of proposed system concepts and upgrades. It defines the total envelope of the operational environments in which NTW must perform from the early stages of initial presence to the end of hostilities and in the key products of Step 1.

FUNCTIONAL BASELINE: The approved documentation describing the NTW functional, performance, interoperability, interface requirements, and the verification required to demonstrate the achievement of those specified requirements. The basis for the Functional Baseline is the CPB defined in Step 3. The Functional Baseline is finalized in Step 4 of this plan.

FUNCTIONAL DESCRIPTION: Hierarchical description of the functions to be performed by the future NTW "system of systems" required to meet the full set of NTW operational requirements. This functional model is developed from the functionality of current NTW systems and a functional decomposition of NTW related operational requirements.

INTEGRATED PRODUCT TEAM: Team composed of representatives from all appropriate functional disciplines working together with a Team Leader to build successful and balanced programs, identify and resolve issues, and make sound and timely recommendations to facilitate decision-making.

LIFE CYCLE COST (LCC): The sum total of the direct, indirect, non-recurring, and other related costs incurred, or estimated to be incurred, in the design, development, production (including manufacture and fabrication), acquisition, test and evaluation, acceptance, operation, maintenance, modernization, deactivation, and support of a configuration item over its anticipated life span.

LIFE CYCLE COST ANALYSIS: The identification, quantification, and qualification of LCC by segment with the purpose of establishing the cost interrelationships and the effect of each contributor to the total LCC.

MEASURE OF EFFECTIVENESS (MOE): Metric used to quantify a systems ability to meet its operational objectives. Examples of top level MOEs include probability of killing or countering a threat, system availability, defended area etc. Top Level MOEs may be decomposed into supporting MOEs. MOEs are typically evaluated for a specific or a series of operational situations or scenarios. MOEs are used to derive lower level technical performance requirements that are allocated to specific functions and subsystems.

MIGRATION PATH: A plan of actions and milestones that addresses the evolution of the current AEGIS Combat System to the FY2010 baseline.

MISSION SUCCESS CRITERIA: Quantitative criteria to be used to assess if a ship, battle group, joint command, etc. will meet an assigned mission. The system being evaluated may be inherently involved in the mission, or it may play only an enabling role. An example would be that the battle group was able to successfully defend a specific area against ballistic missiles with a 99% probability of success.

MISSION SYSTEM REQUIREMENTS REVIEW (MSRR): The final formal review and approval event conducted as Step 5 of the NTW system requirements engineering process.

OPERATIONAL REQUIREMENTS REVIEW: The formal review of the results of Step 0 (Operational Needs and Requirements), Step 1 (Define the Operational Environment), and Step 2 (Define System Boundaries), of the NTW system requirements engineering process.

OPERATIONAL REQUIREMENTS TRACEABILITY MATRIX: A matrix which traces operational requirements from the top level mission area down to the specific element / nomenclatured system. The matrix shows the decomposition and relationship of operational requirements and will be correlated with functional requirements.

PERFORMANCE REQUIREMENT: The extent to which a mission / operation or function must be executed, generally measured in terms of quantity, quality, coverage, timeliness, or readiness.

SURFACE NAVY THEATER AIR DEFENSE (SURFACE NAVY TAD) SYSTEM: An integrated system which is comprised of all Surface Navy related Theater Air Defense resources and their interfaces with non-Surface Navy TAD and other Navy assets.

SYSTEM REQUIREMENTS DOCUMENT: A Requirements document that translates operational requirements into functional, technical performance, interface, interoperability, and verification requirements and allocates those requirements to lower level subsystems. It defines the environment that the system must operate in as well as the threats that the system must address.

EXECUTIVE SUMMARY

Ref: (a) COMNAVSEASYSCOM Memo Ser TAD-SE 8003 of 10 Feb 97

(b) Volume I: System Requirements Engineering of the Systems Engineering Plan for Surface Navy TAD, dated 12 November, 1997

Reference (a) established a pilot program for systems engineering in the Naval Sea Systems Command (NAVSEA) commencing with the Theater Air Defense (TAD) warfare mission area and assigned actions for the implementation of this pilot. PEO(TAD)-SE drafted Volume I (System Requirements Engineering) of the Systems Engineering Plan (SEP) for Navy Theater Wide Theater Ballistic Missile Defense (NTW TBMD) requirements for Navy surface combatants. Hereafter for brevity, Navy Theater Wide Ballistic Missile Defense will be referred to as NTW.

Volume I, which follows, describes the process to be followed in developing NTW requirements for Navy surface combatants. Volume I addresses the need to develop an integrated set of detailed requirements for each Surface Navy system/subsystem that will become an integral part of the implementation of an NTW capability. An equally important objective of this plan is to develop a Systems Requirements Document (SRD) for the NTW mission and product programs. The plan also provides the basis for scheduling, costing, tracking and controlling this system requirements engineering effort. This document represents the initial portion of the systems engineering process. Volume II, which will detail the remainder of the NTW systems engineering, will be developed under the direction of PMS 452. In addition, product specific Systems Engineering Management Plans (SEMPs) will be developed by the respective program offices.

Reference (b), developed by NSWCDD for PEO(TAD)-SE, is part of the overall Theater Air Defense system requirements engineering thrust and was the basis from which this system requirements engineering plan was developed. Additional guidance provided in EIA/IS- 632 Interim Standard Systems Engineering, Department of Defense (DOD) directives and DOD 5000.1 and 5000.2 series instructions was also incorporated into the development of this NTW system requirements engineering plan. Execution of the plan will be jointly led by NSWCDD and the Johns Hopkins University Applied Physics Lab (JHU/APL) under the guidance of PEO(TAD)-SE.

This system requirements engineering plan provides detailed guidance for the execution of TAD system requirements engineering assessment, management and allocation activities at the NTW Theater Ballistic Missile Defense (TBMD) mission level in the context of Joint Theater Warfare. This system requirements engineering effort will build on the Area and NTW efforts to date and apply additional systems engineering rigor to ensure functional completeness and efficiency in establishing the requirements for NTW. Volume I applies systems engineering principles, appropriately tailored, to

determine performance, functional and interface requirements and the allocation of those requirements to the Navy nomenclatured systems to create a cost, schedule and performance balanced NTW capability that supports achievement of joint TBMD mission objectives.

This plan describes the process for developing an SRD that addresses and allocates requirements for the NTW Mission Program and related product programs. The objective is a performance, cost and schedule balanced set of requirements that enable the development of a NTW capability with an optimized contribution to the Joint TBMD Mission circa FY 2010. It is recognized that many system elements have a multiplicity of functions encompassing other warfare areas. However, the NTW functions will be the focus of this system requirements engineering effort with only limited attention given to non-NTW functionality. The major products of this systems engineering process are as follows:

- NTW Functional Baseline, System Architecture and Allocated Baseline* which will be documented in the SRD;
- Final NTW System Requirements Document;
- Migration Path Report describing how to achieve the NTW baseline;
- Non-NTW Systems Interface Requirements Recommendation Report;
- Naval TBMD ORD recommendations;
- Technology Development Requirements Report;
- Interface Sensitivity Analysis Report;
- Risk Reduction Prioritization Report; and
- Design Reference Mission.

The system requirements engineering process defined in this plan is a six-step process in which was tailored from classic systems engineering principles. This six-step process is shown in Figure 1-2 and discussed in detail in Section II of this plan. A brief description of each step is provided below:

- Step 0: Identify Operational Needs and Requirements.

  This step identifies and traces the mission needs and operational requirements from the Joint TBMD Capstone Requirements Document to NTW. The requirements traceability analysis will provide insight into the completeness and consistency of the NTW requirements and allow the documentation of draft recommended changes and modifications to the Naval TBMD ORD.

* The Allocated Baseline in this case is documented in the SRD which the respective Program Offices will use to develop their combat system products.

- Step 1: Define the Operational Environment.

This step defines the NTW Design Reference Mission (DRM) which details the operational environment within which the system attributes and requirement allocations are evaluated. The DRM will be defined in the context of an evolving campaign with the build-up of a Joint Task Force and will contain design-stressing features to evaluate all of the operational requirements. The DRM will be the baseline used in Steps 3 and 4 to evaluate the relative merit of proposed system concepts and upgrades for NTW.

- Step 2: Define the System's Boundaries.

This step describes the functions to be performed by NTW and the boundaries and interrelationships of NTW and its subsystems with other Joint Theater Warfare systems and subsystems. This step will document NTW interfaces and information flow and identify areas where functional relationships cross system boundaries and may result in potential performance sensitivities.

- Step 3: Identify NTW System/Subsystem Key Attributes.

This step identifies the key NTW system and subsystem attributes that significantly contribute to the successful completion of the NTW mission and translates these findings into a Conceptual Performance Baseline (CPB) comprised of top-level functional and performance requirements for NTW.

Step 4: Establish the NTW Functional/Allocated Baseline.

This step evaluates system alternatives, establishes the NTW Functional Baseline (performance, functional, cost, physical) and allocates this baseline to existing and proposed subsystems. A NTW SRD will be used to document the baseline and will be used by the respective program offices to develop their combat systems products. The SRD will define functional, interface, performance and verification requirements. The migration plan to achieve the performance/cost balance NTW capability will also be defined in this step.

- Step 5: Conduct a Mission System Requirements Review (MSRR).

This system requirements engineering process culminates with the MSRR during which the NTW Functional and Allocated Baselines, migration path, non-NTW interface requirements recommendations, technology development requirements and supporting analysis reports are presented to the Navy's senior leadership for concurrence and transition to Program Managers (PM's) for development of their combat systems products.

Throughout the execution of this plan, efforts will be made to utilize the analysis and findings of the past and ongoing TBMD studies including the Navy TBMD COEA and the Systems Engineering Technical Assessment Team (SETAT) Phase I/II. The analysis outlined in this plan supplements the work of those studies and ensures a documented comprehensive top-down systems engineering evaluation of all aspects of NTW.

SECTION 1.0 – OVERVIEW

1.1 INTRODUCTION

The Program Executive Officer, Theater Air Defense Systems Engineering (PEO(TAD)-SE) drafted Volume I (System Requirements Engineering) of the Systems Engineering Plan (SEP) for Navy Theater Wide Theater Ballistic Missile Defense (NTW TBMD) capabilities for Navy surface combatants. Hereafter for brevity, Navy Theater Wide Theater Ballistic Missile Defense will be referred to as NTW. In response to PEO(TAD)-SE tasking, Volume I of the NTW SEP was developed. Volume I describes the process to be followed in defining NTW requirements for Navy surface combatants. The requirements engineering effort defined in this document represents the initial portion of the NTW systems engineering process.

The NTW system requirements engineering process is a part of the TAD systems engineering strategy. Volume I (System Requirements Engineering) of the Surface Navy TAD Systems Engineering Plan, developed by the Naval Surface Warfare Center Dahlgren Division (NSWCDD) for PEO(TAD)-SE and dated 12 November 1997, was the basis from which this NTW System Requirements Engineering Plan was developed. Guidance provided in EIA/IS-632 Interim Standard Systems Engineering, DOD directives and DOD 5000.1 and 5000.2 series instructions was also incorporated into the development of this NTW plan.

This plan addresses NTW System Requirements Engineering prior to Milestone II and provides the basis for scheduling, costing, tracking and controlling the NTW Program's system requirements engineering effort. This effort will develop a comprehensive set of technical system requirements allocated to the product programs with traceability to top level operational requirements. Volume II will detail the remainder of the NTW systems engineering effort and will be developed under the direction of PMS 452. In addition, product specific systems engineering management plans (SEMPs) will be developed by the respective program offices.

1.2 NTW PROGRAM OVERVIEW

The Navy is currently implementing a TBMD capability. This effort will provide the earliest cost-effective capability by upgrading existing systems and leveraging on substantial past investment in these systems and their infrastructure. The Navy's approach entails two acquisition programs: Navy Area TBMD and NTW. The Navy Area TBMD Program's initial capability will be accomplished by modifying the Navy's AEGIS Weapon System (AWS) and integrating the design of the STANDARD Missile 2 Block IVA to enable detection, control and endo-atmospheric engagement of TBM's. However, additional development is required to expand the area defense foundation to full theater capability and to provide protection against medium/long range TBM's for Joint Forces, sea and air lines of communications, command and control nodes, vital political and military assets, supporting infrastructure, population centers, and inland regions within the entire theater. The NTW program is evolving the AEGIS Combat System's (ACS) core elements (AWS - including STANDARD Missile (SM) and Vertical

Launching System (VLS)) and existing battle management, command, control, and communication systems into a TBMD system, with capabilities to engage mid to long range TBM's during their exo-atmospheric flight.

To minimize development risk inherent in this challenging endeavor, a multi-faceted, evolutionary development approach is being pursued. The current NTW development approach consists of two major efforts. One effort is focused on conducting the AEGIS Lightweight Exo-Atmospheric Projectile (LEAP) Intercept (ALI) demonstration. The other effort is composed of several risk reduction activities (RRA) that are focused on reducing specific known technical risks in the development of a NTW tactical system. Upon successful completion of the demonstration, ALI has the potential to provide a tactical stepping stone (providing limited capability) which could be deployed on the road to a full capability system. This early capability is referred to as Block I (BLK I) and full capability is referred to as BLK II.

The ALI includes a series of near-term flight tests which are focused on demonstrating that LEAP technologies can be integrated with a modified STANDARD Missile (SM-3) and AWS to perform exo-atmospheric TBM intercepts. The primary objectives of ALI is to demonstrate collision guidance and physically hit a TBM target with a kinetic warhead (KW) launched from an AEGIS ship. The ALI demonstration was defined to incorporate maximum heritage from the TERRIER LEAP demonstration and the current Navy Area TBMD User Operational Evaluation System (UOES) program. This demonstration consists of a series of increasingly challenging flight tests designed to validate intercept performance capability with live test data. The initial series of flight tests are designated Control Test Vehicles (CTVs) and are designed to successively test the next level of SM-3/AWS integration. The second series of SM-3 flight tests, designated Guided Test Vehicle (GTV), will demonstrate the physical intercept of a LEAP KW with a TBM representative target in exo-atmospheric flight. The NTW tactical system will evolve from this demonstration.

The RRAs are designed to reduce significant technology development risks early, allowing a rapid low risk development of an early capability and/or the tactical system. The purpose of the RRAs are to make investments in the critical technologies necessary to assure the capability of the NTW System to counter an evolving threat. Earlier system analyses indicate that key aspects of NTW will be stressed by advancements in threat capability and RRAs will provide a hedge against such breakouts or countermeasures. This activity is directed at those critical technologies which include, detection and track processing; discrimination, both interceptor and ship based sensors; propulsion and divert; and lethality. This four-year effort includes development and demonstration of algorithms, ship based architecture assessment and modification, hardware design/development/demonstration, bench tests and experiments culminating in a framework and environment to test NTW systems and technologies.

In addition, at the beginning of FY97, the Navy initiated a NTW Cost and Operational Effectiveness Analysis (COEA) directed at supporting a Defense Acquisition Board (DAB). The COEA reported out during the last quarter of FY97. The objective of the Navy TBMD COEA Phase II was to estimate the cost and performance of various interceptor candidates for the NTW mission. These estimates along with results from special studies on target detection and

processing, exo-atmospheric discrimination, endgame effectiveness and marinization will be used to give recommendations on a material selection for the NTW interceptor.

1.3 PURPOSE

In general, the purpose of implementing a systems engineering process is threefold:

- To ensure all system requirements, specified or derived, are incorporated into the system design and are verifiable;
- To optimize the development process for the product to be provided for the warfighter by maintaining a traceable, integrated baseline; and
- To readily allow assessment of overall design maturity and risk during the decision making process to avoid costly downstream design changes and cost or schedule growth.

This volume of the NTW SEP partially addresses the above general purposes and is focused on providing detailed guidance for the execution of TAD system requirements engineering assessment, management and allocation activities at the TBMD mission level for NTW in the context of Joint Theater Warfare. This requirements engineering effort will build on the Area and NTW efforts to date and apply additional systems engineering rigor to ensure functional completeness and efficiency in establishing the requirements for NTW. Volume I applies systems engineering principles, appropriately tailored, to determine performance, functional and interface requirements and the allocation of those requirements to the individual Surface Navy TAD nomenclatured systems to create a performance, cost and schedule balanced NTW capability that supports achievement of Joint TBMD mission objectives.

This plan defines the process to be used in establishing requirements for individual nomenclatured systems to ensure that they support overall NTW requirements and addresses the System Requirements Engineering prior to Milestone II. Because NTW is a part of the overall Surface Navy TAD strategy, the processes addressed in this plan are part of the overall PEO(TAD)-SE systems engineering thrust described in the Surface Navy TAD Systems Engineering Plan which prescribes the systems engineering effort for the Surface Navy TAD "system of systems" and individual nomenclatured systems. Volume I does not explicitly address all of the systems engineering processes to be used by individual NTW elements (i.e., nomenclatured systems) once functional, performance, interface and interoperability requirements have been established by the systems engineering effort defined in this plan.

1.4 SCOPE

Figure 1-1 illustrates the scope of NTW in the larger system context of Joint TBMD. The product programs in the bottom line of systems or elements of systems which can be employed to perform NTW today and provide a baseline from which future systems can be built to perform future NTW TBMD. The non-NTW systems will be represented in this effort as top-level

performance elements with their respective interfaces to NTW. Within Navy TBMD as shown in Figure 1-1, there are three levels that support Joint TBMD:

- Navy TBMD Mission Area;
- NTW Mission Program; and
- Product Programs (nomenclatured systems).

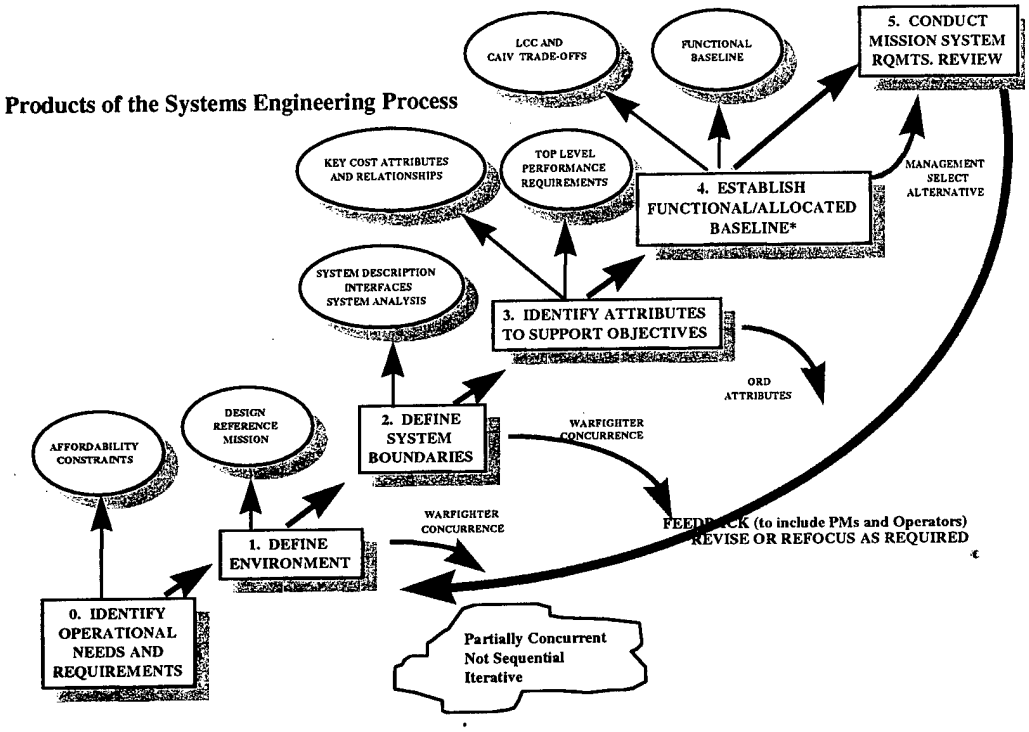

Figure 1-1. PEO(TAD)-SE Common System Requirements Engineering Process

One intent of this plan is to define the process for developing a NTW System Requirements Document (SRD) that addresses and allocates requirements for each of these levels. The objective is a performance, cost and schedule balanced set of requirements that enable the development of a NTW capability with an optimized contribution to the Joint TBMD Mission.

It is recognized that some NTW System elements have a multiplicity of functions encompassing other warfare areas. However, the NTW functions will be the focus of this system requirements engineering effort with only limited attention to non-NTW functionality.

The common system requirements engineering process which is composed of Steps 0 through 5 is illustrated in Figure 1-2. This common process has been tailored for NTW system requirements engineering which will be discussed in detail in Section II.

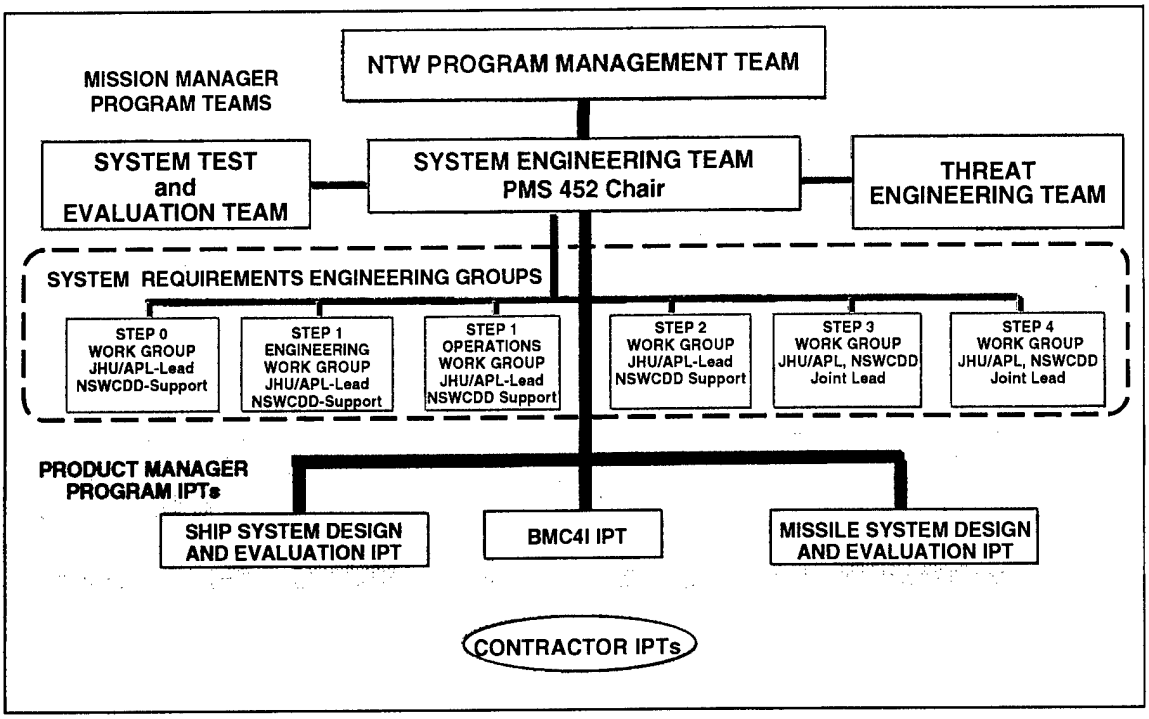

Figure 1-2. Management Structure for NTW System Requirements Engineering Execution

Work will begin with efforts to identify and organize existing mission needs and operational requirements pertaining to the NTW System. The Design Reference Mission (DRM) will be defined from both Navy and Joint perspectives and will be based on Defense Planning Guidance and consideration of design stressing aspects of the TBMD mission. Steps will be taken to determine system functions and boundaries and key attributes of NTW. A Conceptual Performance Baseline (CPB) will be developed that includes top-level functional and performance requirements for NTW.

A series of assessments will be conducted to evaluate candidate NTW implementation concepts stressing performance and life-cycle cost at the TBMD Mission Area to provide the following results:

- Determine NTW cost balanced performance and functional requirements for candidate enhancements and/or new developments in the form of a SRD that addresses each product element (nomenclatured system); and
- Define the migration path to the performance/cost balanced NTW fully capable system.

Alternative concepts will be refined throughout the assessment process to provide the best possible basis for the Allocated Baseline definition. An SRD and migration paths will then be prepared as appropriate to support a Mission System Requirements Review (MSRR) for NTW. The focus of this plan is on pre-Milestone II aspects of NTW. This effort (Steps 0-5) will take full advantage of all past and ongoing efforts and will make maximum utilization of existing documentation and analyses, i.e., Global Protection Against Limited Strike (GPALS) Feasibility Study, ASN Anti-Tactical Ballistic Missile (ATBM) Study, Concept Evaluation Integration Study (CEIS), AEGIS/Theater High Altitude Air Defense (THAAD) Integration Study, Navy TBMD COEA Phase I/II, SETAT Phase I/II, etc. This effort provides the framework in which a structured system requirements engineering process maps functional requirements to the NTW Mission area. Additional analysis will occur when holes and deficiencies are identified or when concerns at the Joint Mission Area require further investigation.

The SRD will be the basis for the Program Managers' development of the nomenclatured subsystems to implement the NTW capability. Figure 1-3 shows the relationship of the NTW SRD to the warfighter generated Top Level Operational Requirements and to the individual program Top Level Requirements (TLRs) and specifications. In addition to the NTW SRD, the system requirements engineering process will provide recommendations for additions and modifications to the Naval TBMD ORD as appropriate.

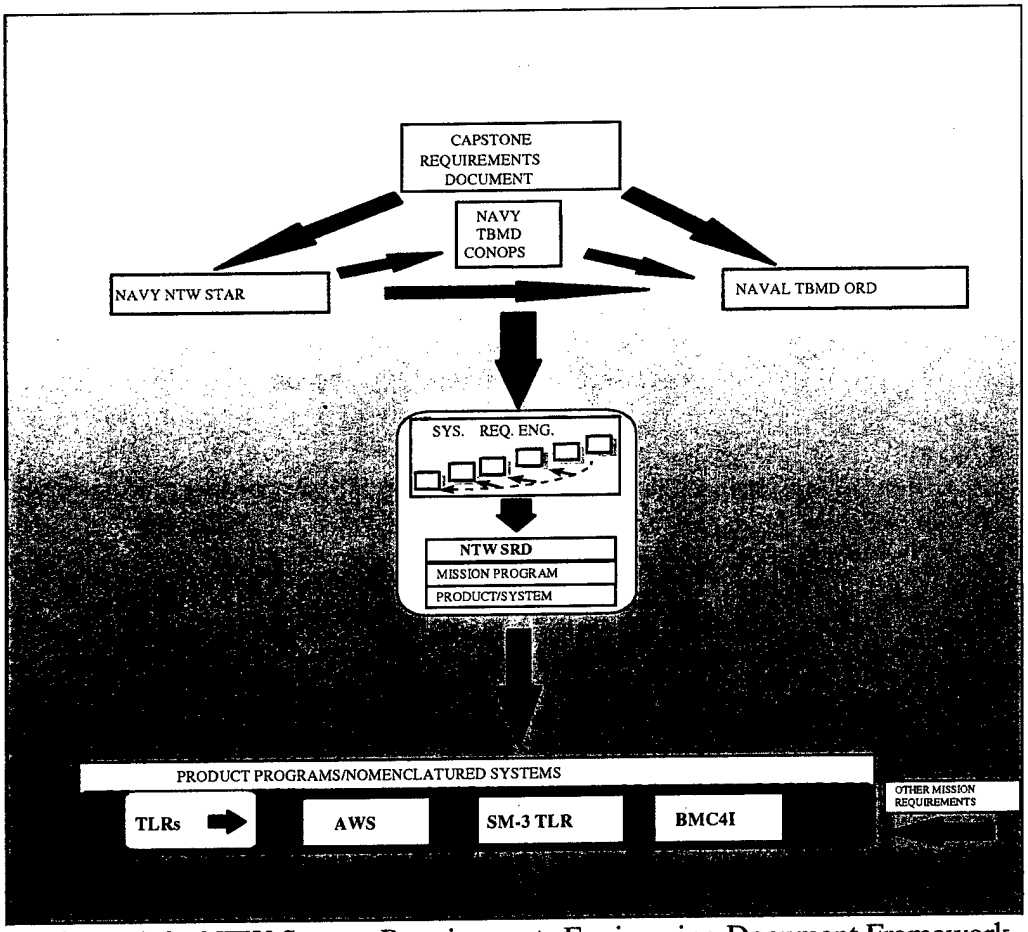

Figure 1-3. NTW System Requirements Engineering Document Framework

Figure 1-4 illustrates the relationship of the system requirements engineering process described in this plan to the general acquisition milestones and the remainder of the system development process. This system requirements engineering process will determine the NTW Conceptual Performance, Functional and Allocated baselines. The mission and product program managers are responsible for taking the allocated requirements and developing the individual systems which constitute the NTW System. The mission and product program managers will be responsible for establishing processes in their individual SEMPs to maintain traceability to the NTW requirements. Since the NTW system requirements engineering process will only generate a top or first level allocation, additional iterations of the system engineering process are performed by the product program managers to define the lower level allocated and product baselines. These product baselines will be used for the actual development of the equipment and computer programs.

1.5 TECHNICAL PROGRAM MANAGEMENT AND CONTROL

Management and control activities are intended for directing, tracking, and reviewing program accomplishments, results, and risks against documented estimates, commitments, and plans. Appropriate corrective actions can then be taken when performance deviates significantly from plans.

1.5.1 General Systems Engineering Roles and Responsibilities

The general system requirements engineering roles and responsibilities are taken from the 16 June 1997 draft PEO(TAD) guidance and policy paper on TAD systems engineering roles and responsibilities. The significant investment in people and facilities necessary to execute each phase of the system requirements engineering process requires organizational focus and commitment for proper execution. The need to develop solutions that optimize cost and effectiveness at the TAD mission level of system make it necessary to establish a more formal and enduring structure for the execution of system requirements engineering. PEO(TAD) has assigned the following roles and responsibilities for Navy TAD systems engineering. Leadership roles do not imply exclusive dominance.

1.5.1.1 TAD Systems Engineer

The PEO(TAD) Systems Engineer, TAD-SE, is responsible to the PEO for the technical and system architecture of all TAD systems. TAD-SE defines the system engineering process that TAD programs will follow and provides budget inputs to Program Managers (PMs) for implementation of that defined system engineering process. Important to this process is allocation of functions to systems and components for Program Manager (PM) implementation. TAD-SE will direct the PEO systems engineering processes, including those at Johns Hopkins University/Applied Physics Laboratory (JHU/APL) and Naval Surface Warfare Center, Dahlgren Division (NSWCDD). TAD-SE is charged with supporting PMs in the overall implementation

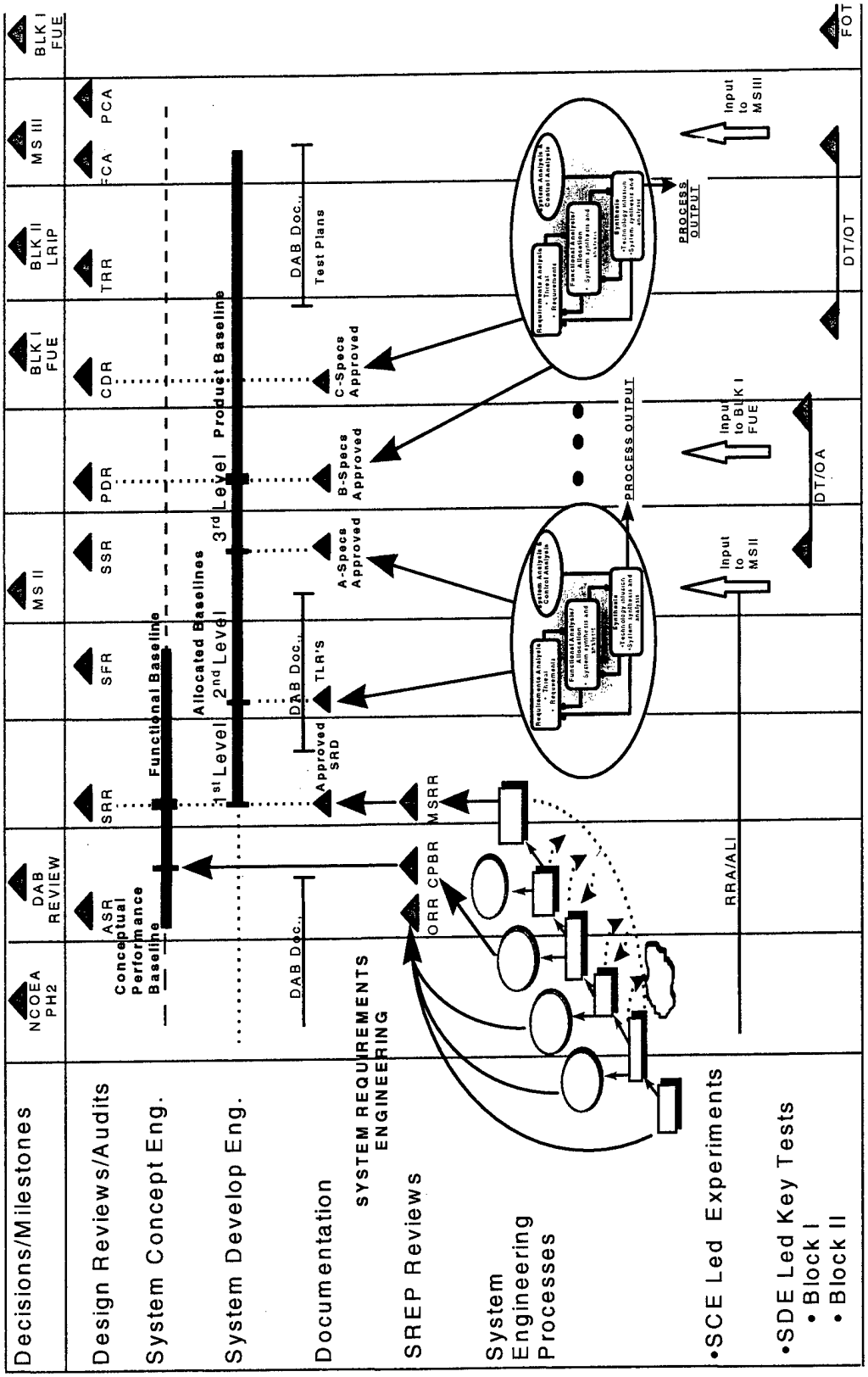

Figure 1-4. Relationship of NTW System Requirements Engineering to Acquisition Milestones

1.5.1.2 Systems Concept Engineer

The Johns Hopkins University/Applied Physics Laboratory (JHU/APL) is assigned the role of PEO(TAD) Conceptual Systems Engineer. In this role, JHU/APL shall develop system concepts, with risk reduction approaches including prototyping as necessary, for all TAD systems and major upgrades. These concepts shall be formulated into a Conceptual Performance Baseline which will be the basis for Functional Baselines for TAD systems. JHU/APL shall certify to PEO(TAD) that the Conceptual Performance Baseline and its functional allocation satisfies the mission need with a design that is balanced in performance, cost and schedule. JHU/APL shall continue to monitor the development to assure that the integrity of the concept and its performance is maintained as the development matures. JHU/APL will have a supporting role in the development of Allocated Baselines. The objectivity necessary to carry out this role precludes assignment of design agent functions to the system concept engineer except under special circumstances approved by the PEO.

1.5.1.3 Systems Development Engineer

The NSWCDD is assigned the role of PEO(TAD) Systems Development Engineer. NSWCDD has the responsibility to accept the Functional Baseline for the Program Manager. Acceptance of the Functional Baseline shall include the verification that the Functional Baseline meets the requirements for all TAD systems and major upgrades. NSWCDD is responsible for certifying to PEO(TAD) that the Functional Baseline is consistent with the approved Conceptual Performance Baseline and satisfies the mission need with a design that is balanced in cost and performance for the specified need date. As the Systems Development Engineer, NSWCDD has lead government responsibility for the development of the Allocated Baseline for all TAD systems and major upgrades. NSWCDD has lead responsibility for government oversight deemed necessary by the Program Manager for government acceptance of the product baseline. In this capacity, NSWCDD is responsible for certifying to the PEO that the Allocated Baseline fully implements the requirements of the Functional Baseline and satisfies mission need while maintaining cost and performance balance and schedule. NSWCDD will have a major supporting role in the development of new system concepts and technologies, as well as a supporting role in the development of the Conceptual Performance and Functional Baselines.

1.5.1.4 TAD Program Manager

Individual PMs are responsible for planning and budgeting all phases of engineering. The assigned TAD Systems Engineer is responsible to the PM for performance, cost and schedule management of systems engineering and to TAD-SE for compliance with technical policy and requirements. The PM is responsible for the technical integrity of the system throughout the system life, for selection between technically acceptable design alternatives and determination of the degree of acceptable risk. Program Managers are encouraged to identify and implement specific system engineering taskings in concert with this policy.

1.5.2 Management Structure for Plan Implementation

A high-level diagram of the management structure for execution of this NTW system requirements engineering plan is shown in Figure 1-2.

1.5.2.1 NTW Program Management Team

An NTW Program Management Team will be formed to provide top level program manager guidance. PMS 452 will lead NTW Program Management Team with team members shown in Table 1-1. The responsibilities of the NTW Program Management Team are to:

- Provide program planning and direction;
- Provide funding;
- Resolve conflicts of interests and competing priorities;
- Conduct independent reviews;
- Provide program assessment and recommendations to higher level leadership;
- Provide program coordination with the Defense Acquisition Board (DAB); and
- Obtain DAB documentation approval.

Table 1-1. NTW Key Agency Participation

ORGANIZATION	REVIEW PARTICIPANTS					STEP 0	STEP 1		STEP 2	STEP 3	STEP 4
	ORR	PBR	SRR	NTW PROG MGT TEAM	NTW SYS ENG TEAM	WORK GROUP	WORK GROUPS		WORK GROUP	WORK GROUP	WORK GROUP
							ENG	OPER			
PEO(TAD)											
PEO(TAD)-SE				√							
PMS 452	*	*	*	√*	√*	√	√	√	√	√	√
PEO(TAD)-SE STAFF					√	√	√	√	√	√	√
BMDO						√	√	√	√	√	√
SPAWAR											
PEO SC						√	√	√	√	√	√
CWSE											
CSSE											
OTHER EFFECTED SYSTEMS PMs/SEs				√	√	√	√		√	√	√
CNO N86						√				√	
CNO N6											
JTAMDO						√					
NDC											
FLEET CINCS						√		√		√	
NSWCDD				√	√	√	√	√	√	√*	√*
NSWC											
JHU/APL				√	√	√*	√*	√*	√*	√*	√*
MIT/LL					√	√	√		√	√	√
NSWCPHD						√	√	√	√	√	√
INDUSTRY					√						√
INTEL COMMUNITY						√		√			
OTHER	AS NECESSARY										

* Lead

NSWCDD/MP-99/12

1.5.2.2 NTW System Engineering Team

A NTW System Engineering Team (SET) will be formed which will be responsible for the allocation and management of cost and schedule milestones and exit criterion to the Systems Concept Engineer and Systems Development Engineer based upon the agreed allocations from PMS 452. The PMS 452 System Engineer will lead the SET with Team members as shown in Table 1-1. Some of the tasks that the SET would be chartered to perform, but not limited to, are:

- Coordinate development, review and approval of:
  - ORD and SRD;
  - SEMP;
  - Mission requirements and design;
  - Risk reduction; and
  - System Design Reviews.
- Provide:
  - Program integration;
  - Ship combat system engineering input;
  - DAB support;
  - Technology transition plan; and
  - Coordination with external organization functions.

1.5.2.3 Product IPTs

Depending upon the specific situation, the SET will charter a number of mission product IPTs that will be charged with the responsibility of managing the development o fits specific area. These areas might include ship combat system engineering design, BMC4I, missile system design, threat definition or T&E. These IPTs would be chaired by Product SET and would typically include the following members:

- PMS 422
- PMS 410
- PEO SC
- JHU/APL
- NSWCDD
- MIT/LL
- Mission Area engineer
- SEA&I contractor
- System design contractor representative

Some of the tasks that these IPTs would be chartered to perform, but not limited to, are:

- Coordinate development, review and approval of:

  - Ship system engineering (including all subsystem elements, i.e., combat system, BMC4I, etc.)
  - Threat definition
  - TEMP
  - Flight test plans
  - Failure analyses
  - TLRs
  - PIDS
  - CM plan for a CI

1.5.2.4 PEO(TAD) system Engineer – Plan Execution Responsibilities

The PEO(TAD) Systems Engineer, (TAD)-SE, has the general systems engineering responsibilities discussed in 1.4.1.1. The PEO(TAD)-SE responsibilities for the execution of this plan are as follows:

- Be a member of the NTW Program Management Team; and
- Be responsible for the executive oversight of the TAD system engineers for the execution of this plan. This oversight responsibility encompasses the PMS 452 System Engineer as well as the NTW effected TAD product program system engineers.

1.5.2.5 PMS 452 and PMS 452 System Engineers – Plan Execution Responsibilities

PMS 452 and his system engineers support this system requirements engineering process as follows:

- PMS 452 will lead the NTW Program Management Team;
- Provides Mission Program guidance;
- Leads the formal reviews of the plan execution including the Operational Requirements Review, (ORR), Conceptual Performance Baseline Review, (CPBR), and Mission System Requirements Review (MSRR);
- NTW System Engineer leads the System Engineering Team;
- Be a member of the Step 0 Work Group;
- Be a member of the Step 1 Engineering Work Group;
- Be a member of the Step 2 Work Group;
- Be a member of the Step 3 Work Group; and
- Be a member of the Step 4 Work Group.

1.5.2.6 JHU / APL – Plan Execution Responsibilities

JHU/APL as the PEO(TAD) Conceptual Systems Engineer has the general systems engineering responsibilities addressed in 1.4.1.2. The JHU/APL responsibilities for the execution of this plan are as follows:

- Be a member of the NTW Program Management Team;
- Be a member of the NTW System Engineering Team;
- Leads the Step 0 (Operational Needs and Requirements) Work Group;
- Leads the Step 1 (Define the Operational Environment) Engineering Work Group;
- Leads the Step 1 Operational Work Group;
- Leads the Step 2 (Define System Boundaries) Work Group;
- Co-leads the Step 3 (ID System/Subsystem Attributes) Work Group with NSWCDD;
- Co-leads the Step 4 (Establish the Allocated Baseline) Work Group with NSWCDD;
- Leads the development of the Conceptual Performance and Functional Baselines;
- Be responsible for certifying to PEO(TAD) that the Conceptual Performance Baseline is consistent with the operational requirements;
- Be responsible for certifying to PEO(TAD) that the Functional Baseline is consistent with the approved Conceptual Performance Baseline;
- Participate in the ORR, CPBR and MSRR formal reviews.

1.5.2.7 NSWCDD – Plan Execution Responsibilities

NSWCDD as the PEO(TAD) Systems Development Engineer has the general systems engineering responsibilities addressed in 1.4.1.3. The NSWCDD responsibilities for the execution of this plan are as follows:

- Be a member of the NTW Program Management Team;
- Be a member of the NTW System Engineering Team;
- Co-leads the Step 3 (ID System/Subsystem Attributes) Work Group with JHU/APL;
- Co-leads the Step 4 (Establish the Allocated Baseline) Work Group with JHU/APL;
- Be responsible for the acceptance of the Functional Baseline which includes verification that the Functional Baseline meets the operational requirements and Conceptual Performance Baseline;
- Leads government responsibility for the development of the NTW Allocated Baseline;
- Provides a major supporting role in the execution of the following steps as well as membership in the work groups:
  - Step 0 (Identify Operational Needs and Requirements) Work Groups;
  - Step 1 (Define the Operational Environment) Operational Work Group and Engineering Work Group;
  - Step 2 (Define the System Boundaries) Work Group; and
- Participates in the ORR, CPBR and MSRR formal reviews.

1.5.2.8 PEO(TAD) and PEO SC Product Program Managers – Plan Execution Responsibilities

The product program managers have the general systems engineering responsibilities addressed in 1.4.1.4. The product program managers and their system engineers support this system requirements engineering process as follows:

- Be a member of the NTW Program Management Team;
- Be a member of the NTW System Engineering Team;
- Be a member of the Review Panel at ORR, CPBR and MSRR;
- Be a member of the Step 0 Work Group;
- Be a member of the Step 1 Engineering Work Group;
- Be a member of the Step 2 Work Group;
- Be a member of the Step 3 Work Group; and
- Be a member of the Step 4 Work Group.

1.5.2.9 System Requirements Engineering Groups

Step 0 Work Group - A requirements work group of personnel from JHU/APL, NSWCDD and other technical organizations listed in Table 1-1 will be responsible for the collation and reconciliation of the NTW operational requirements and needs. The Requirements Work Group will be the primary forum for reconciliation of the requirements and oversight of the generation of the traceability matrix. The Step 0 Work Group will be led by JHU/APL and supported by NSWCDD.

Step 1 Work Groups - Two work groups will be established to support different aspects of the operational environment definition. The participants of each work group are listed in Table 1-1. The work groups have representation from many of the same organizations, but the type of expertise is quite different. Each work group will report to the overall Step Lead, JHU/APL, who will be responsible for coordinating issues and recommendations between Work Groups and incorporating the recommendations. NSWCDD will support JHU/APL on this effort.

The Operational Work Group will be comprised of warfighters and personnel with experience in fleet operations. The Operational Work Group will provide guidance and review of the operational situations to ensure that they represent how the forces would be deployed and operate.

The Engineering Work Group will be comprised of TAD analysts and design experts. It will provide a preliminary set of threat and environmental characteristics that stress each aspect of the NTW System. The Engineering Work Group also will be responsible for reviewing the documentation of resulting situations to ensure that information required for modeling and evaluation in Steps 3 and 4 is included.

Step 2 Work Group - To ensure that the functionality of current and future NTW subsystems are captured, representatives from the nomenclatured system technical community will participate in the development of the functional descriptions developed in this step. A series of working groups made up of NSWCDD, JHU/APL, TAD systems engineering personnel, representatives from the nomenclatured systems under consideration and other personnel listed in Table 1-1 will be utilized to ensure both a consistency of approach and depth and accurate capturing of current and future system functionality and interfaces. The Step 2 Work Group will be led by JHU/APL and supported by NSWCDD.

Step 3 Work Group - A work group will be formed which will be responsible for the development of the NTW Conceptual Performance Baseline. This work group will identify system attributes, functions, and success criteria to be used in the development of the functional, performance, and cost requirements for NTW. The Step 3 Work Group will be co-led by JHU/APL and NSWCDD and supported by representatives listed in Table 1-1.

Step 4 Work Group - A work group comprised of personnel from NSWCDD, JHU/APL, PEO(TAD)-SE, effected program managers and systems engineers, and other personnel identified in Table 1-1 will be utilized during this step to provide guidance, oversight and detailed planning for the development of the functional and allocated baselines for future NTW. The work group will play a key role in defining the alternatives to be considered and selecting alternatives for detailed analysis and further consideration. The work group will review the final recommended alternative and supporting analyses to ensure all relevant issues have been considered and that it supports the operational, performance, and mission success criteria that have been established in earlier steps. The Step 4 Work Group will be co-led by JHU/APL and NSWCDD.

1.5.3 Technical Reviews

Figure 1-5 illustrates the PEO(TAD)-SE common process with emphasis on the three formal reviews.

- The Operational Requirements Review (ORR) will be held after completion of Steps 0, 1 and 2 to obtain concurrence that the initial requirements, evaluation environment and understanding of the systems involved are adequate to proceed with the identification of the key system attributes and top-level performance requirements in Step 3.
- The Conceptual Performance Baseline Review (CPBR) will be held to present the options, risks and recommendations for the functional and performance requirements for approval prior to Step 4 allocation.
- The Mission System Requirements Review (MSRR) for NTW will be held to obtain approval of the recommended NTW baseline and the proposed migration path.

The exit criteria for the reviews will be the approval of the information required at the review and the completion of the step documentation. Additional details on the information presented at each review and the required documentation is provided in the description of each step in Section II and the list of deliverables in Section III.

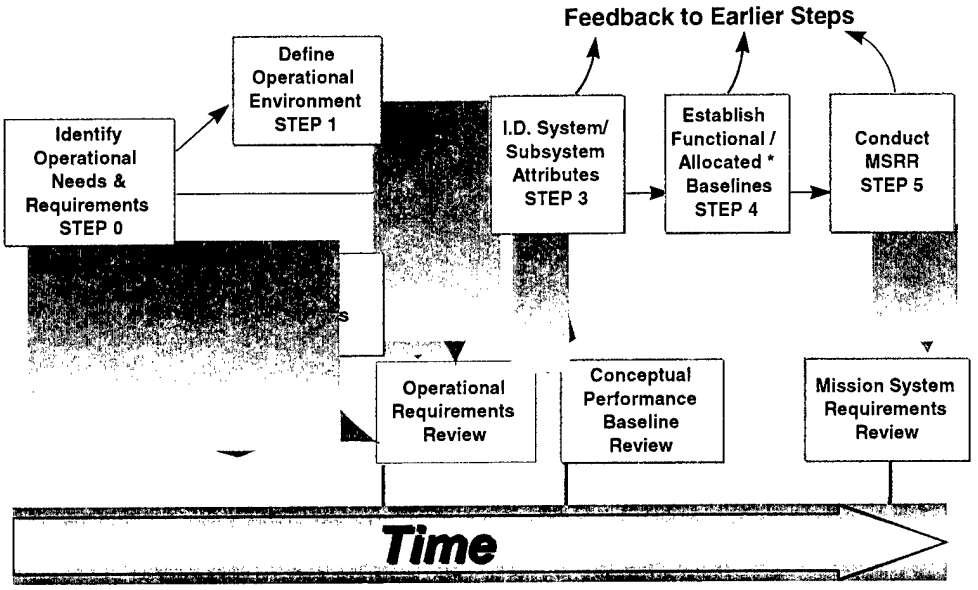

Figure 1-5. Reviews for the System Requirements Engineering Process

1.5.4 Internal/External Organizations

A number of Navy and external agencies may have important roles in the NTW program. Surface Navy agencies including SECNAV, OPNAV and the systems commands will have significant roles in shaping a Navy-wide approach to NTW. Agencies external to the Navy, including JTAMDO and BMDO, will have significant roles in shaping a joint warfighting system for TBMD. The PEO(TAD)-SE organization and system requirements engineering process is expected to establish and maintain appropriate interfaces with each of these agencies. Key agencies and their expected participation in NTW requirements definition and technical review activities are shown in Table 1-1. Industry will be included in Step 4 as part of this process.

1.5.5 Customers

Customers are the reason the products of the system requirements engineering process exist, and as such, are an essential element of those processes. The systems engineers, analysts and technical experts will determine the performance, cost and schedule requirements at the top level. The primary customers, the end users, require reliable effective solutions to operational problems that are balanced with cost and schedule. The immediate customers, the program managers, continue to refine performance, cost and the schedule constraints throughout the development process in an effort to field successful products to these end users. The end user must understand the capabilities, limitations, design and detailed workings of the systems to be built, since they must eventually use, maintain, and even enhance the delivered system. This plan engages the participation of a number of Navy and external agencies as delineated in Section 1.4.4.

1.6 BLK I SRD

As described in the Program Overview, NTW is envisioned as an evolutionary development with the early deployment evolved from a modified ALI, designated BLK I, on the path to a full tactical capability, designated BLK II. BLK I is driven by schedule and risks, i.e., a mandate for deployment as early as feasible to provide a limited capability against a portion of the threat and minimum technical risks to accommodate the schedule. Because the planned deployment of BLK I is early in the next decade, the functional and allocated baselines need to be established by the second quarter of FY 98.

To support this effort an SRD for the BLK I will be developed in parallel with the structured system requirements engineering process for the full NTW capability. This BLK I SRD will not employ the rigorous engineering process described in the remainder of this document. Rather, the SRD will be developed with design fixed by allowable modifications of the ALI and accompanying elements. The resulting capability will be mapped to the threat set corresponding to the performance of the BLK I. The schedule for the development of the BLK I SRD is shown in Figure 1-6.

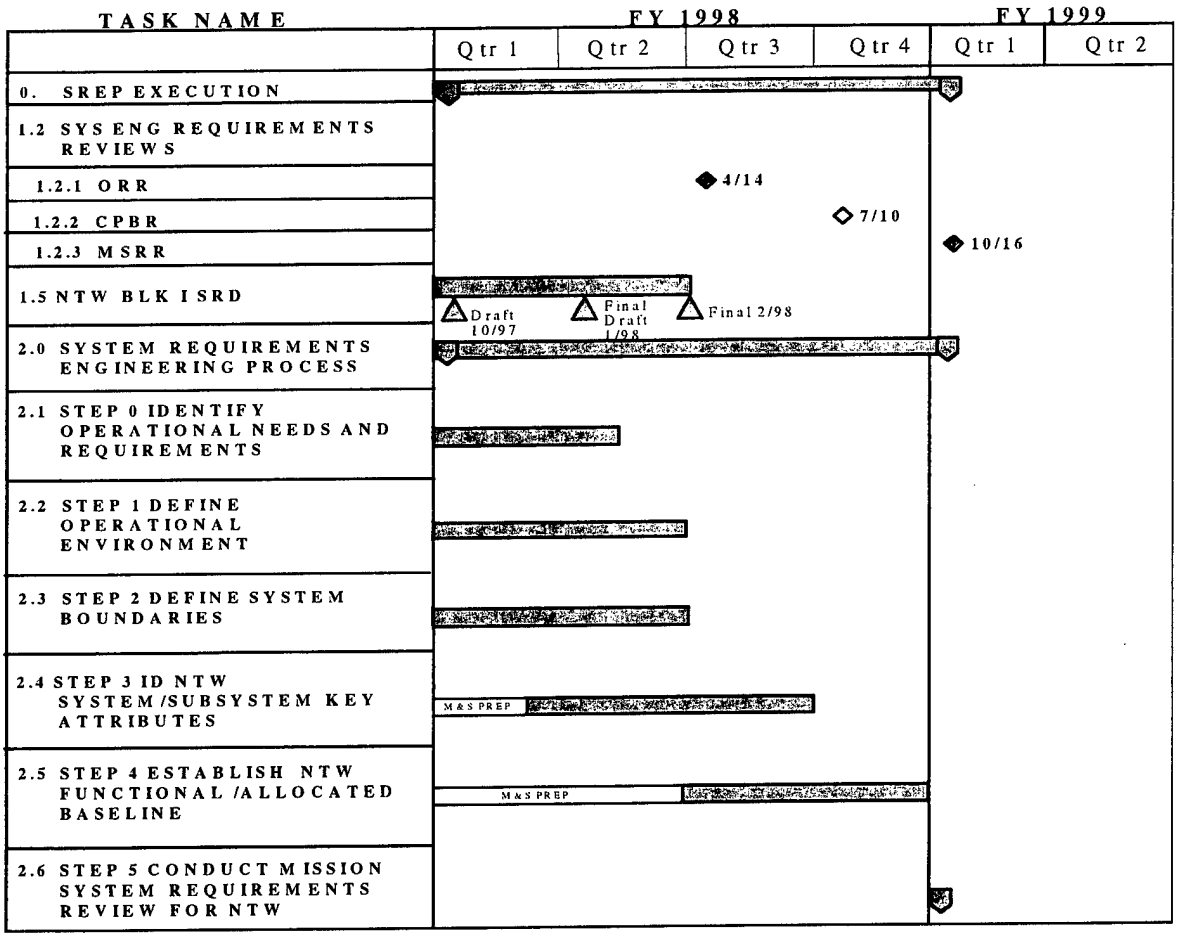

Figure 1-6. NTW System Requirements Engineering Summary Schedule

1.7 SCHEDULE

The schedule for this requirement plan's execution is driven by the need to support the input for NTW in POM 00. Although Figure 1-2 shows the system requirements engineering process being sequential steps, the first three steps will be executed essentially in parallel. This will enable the interaction and passing of information generated in the various steps. The interaction between the steps is detailed in the step description in Section II and the detailed schedule in Section III. This parallel step execution will reduce the amount of reiteration required and enable the execution of the overall process within one year. In addition to the parallel start of the early steps, the preparations of the modeling and simulation facilities and tools for Steps 3 and 4 will commence at the initiation of the overall plan.

SECTION 2.0 – SYSTEM REQUIREMENTS ENGINEERING PROCESS

This section describes the technical approach and the system requirements engineering process as applied to NTW.

2.1 INTRODUCTION

As discussed in Section I, Theater Air Warfare systems engineering involves a hierarchy of systems. Systems at any one level are embedded in successively higher level systems that address discrete operating tasks, mission areas, and ultimately joint operating forces. Therefore, NTW can be viewed as an integrated system which is comprised of all Surface Navy related NTW resources and their interfaces. This NTW System, or capability, is made up of various subsystems. Similarly, the NTW "System" is a subsystem of the broader Navy TBMD, Joint TBMD and Theater Air Warfare "system of systems". The primary product of this system requirements engineering process is an NTW SRD. The SRD's development will be discussed in the introductory technical approach as well as where appropriate in each of the process steps.

2.2 SYSTEM REQUIREMENTS ENGINEERING TECHNICAL APPROACH

The system requirements engineering process technical approach is the tailored application of classical systems engineering concepts specifically to meet the needs of NTW.

The system requirements engineering technical approach described below is founded on lessons learned over the past decades. At the top-level and at every intermediate level, the approach requires the identification of inputs, required outputs, and the processes necessary to produce the outputs. The approach is shown below in Figure 2-1.

Inputs: As shown in the adjacent figure, the NTW system requirements engineering approach starts with the identification of inputs. For NTW system requirements engineering, they are:

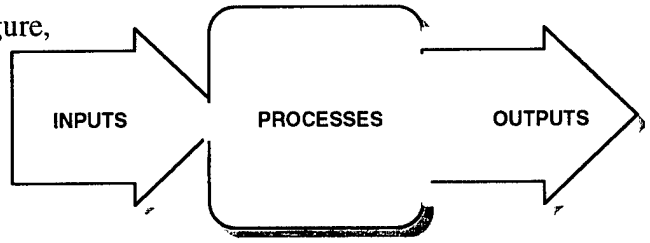

Figure 2-1. PEO(TAD)-SE General

- PMS 452 guidance;

Current NTW requirements;

- Projected force structure;
- DPG/Warfighter inputs;
- Current and projected threats;

- Natural and man-made environment (including electromagnetic effects) in which the NTW System must operate;
- Available state-of-the-art technology and technology trends;
- Results of TBMD COEAs;
- JTAMDO analysis;
- Results of other TBMD studies/analyses; and
- Analysis tools (e.g. M&S).

Outputs: Outputs are the next actions identified. The outputs are defined early, as they determine the required inputs and dictate processes. The NTW system requirements engineering outputs consist of:

- NTW Functional Baseline, System Architecture and Allocated Baseline which will be documented in the SRD;
- Final recommended NTW System Requirements Document;
- Migration Path Report describing how to achieve the NTW baseline;
- Non-NTW Systems Interface Requirements Recommendation Report;
- Naval TBMD ORD recommendations;
- Technology Development Requirements Report;
- Interface Sensitivity Analysis Report;
- Risk Reduction Prioritization Report; and
- Design Reference Mission.

The final element is defining the processes required to take the input and perform the actions, which are required to deliver the desired output. PEO(TAD)-SE has developed a common system requirements engineering process which is described in Reference (a). This process has been tailored for NTW and is described in Section 2.2. Each of the steps must remain under continuous scrutiny for iterative improvement as the plan for system requirements activities is executed. PEO(TAD)-SE's system requirements engineering technical approach for NTW is shown in Figure 2-2.

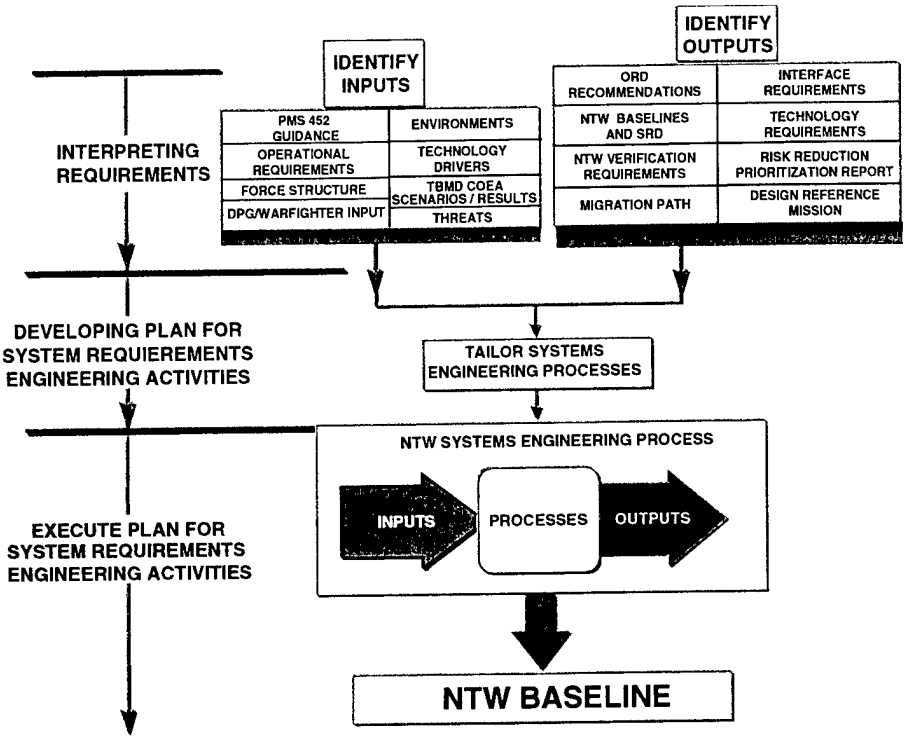

Figure 2-2. NTW System Requirements Engineering Technical Approach

2.2.1 System Requirements Engineering Process Tool Selection

To facilitate the large amount of information that needs to be collected and analyzed, a systems engineering tool or set of tools will be selected. These tools are computer programs and databases designed to support and track data collected and developed during the system requirements engineering process. This systems engineering tool does not include performance and cost modeling and simulation. See Sections 2.1.2 and 2.6.3 for a discussion of modeling and simulation tools. It will be a goal to select a tool that will be compatible with lower level NTW systems development tools. The systems engineering tools must provide the following capabilities:

- Traceability of top down requirements and functions;
- Extraction of requirements and descriptions from existing documentation;
- Building of functional and physical hierarchical models and provide mapping between the models;
- Modeling of control features as well as data flow;
- Analysis of interfaces; and
- Generation of reports which are compatible with standard word processing and graphics tools.

Candidate systems engineering tools are:

Tool	Company
RDD-100	Ascent Logic Corp.
Product Track	Cimflex Tecknowledge Corp.
Vital Link	Compliance Automation, Inc.
RTM	Marconi Systems Tech.
Cradle SEE	Mesa Systems Guild, Inc.
Spec Writer	PRC, Inc.
SLATE	TD Technologies
Require	Unisys Corp.
CORE	Vitech Corp.
DOORS	Quality Systems Software (QSS) Corp.
CASETS	Boeing

2.2.2 Modeling and Simulation Tool Selection

To assess system performance, it is necessary to use modeling and simulation tools. Several different types of models (in particular cost and performance models) may be needed to address the entire system. Critical functions and attributes will need to be analyzed to identify the most cost effective and highest performance system. Section 2.6.3 addresses the modeling strategy needed to select the proper modeling and simulation tools.

2.2.3 Communications

The use of templates for select elements of the system requirements engineering process can greatly aid the systems engineer to ensure commonality of process and resulting products. The template, as well as guidelines for its use, will be maintained in an electronic program library. To this end, TAD will use the following documentation template for the communication of system requirements engineering results:

- Systems Engineering Memorandum (SEM). The SEM will be the prevalent template used across the program. All documentation associated with technical baseline development, modification including cost and schedule, trade studies, risk assessments or verification will be attached or documented in the SEM.

Additional templates may be used if warranted as the system requirements engineering process is executed.

2.2.4 Documentation of Results

Documentation management, process documentation and configuration control are important activities in traditional systems engineering and are ever more crucial in Integrated Product/Process Development (IPPD) implementation. The concurrency of efforts, the numerous tradeoffs being conducted and successive prototypes under investigation make the documentation process an integral part of IPPD implementation. The primary product of the system requirements engineering effort described in this plan is the SRD. The process for the SRD's development is illustrated in Figure 1-3. The details on other documents and configuration management baselines are addressed in each step of the system requirements engineering process.

2.3 THE NTW SYSTEM REQUIREMENTS ENGINEERING PROCESS

The NTW system requirements engineering process to be used is a six step common process culminating in the identification of the NTW baseline requirements (System Requirements Document), interface requirements recommendations for non-NTW systems contributing to the NTW mission, definition of migration path, identification of technology development requirements, and production of analysis reports on which the Navy's senior leadership can concur and support POM planning.

PEO(TAD)-SE has developed a common system requirements engineering process. This process is initiated by the capture of the mission requirements, which has been included as Step 0 in this plan. Each step has been summarily decomposed into its respective sub-processes and is described in Sections 2.3 through 2.8 of this plan. Decomposition of each step follows the model described previously in that inputs, processes and outputs are identified for each step. At the top-level as well as at each sub level (step) the processes need to be flexible, responsive, and designed with control points to measure effectiveness.

The six system requirements engineering steps followed by this plan are:

- Step 0: Identify operational needs and requirements;
- Step 1: Define the operational environment in which NTW will perform;
- Step 2: Define the system's boundaries;
- Step 3: Identify NTW system/subsystem key attributes;
- Step 4: Establish the NTW Functional/Allocated Baselines; * and
- Step 5: Conduct a Mission System Requirements Review (MSRR) for NTW.

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* The Allocated Baseline is documented in the SRD, which the respective Program Offices will use to develop their combat system products.

As shown in Figure 2-3, the system requirements engineering process is not a single pass action. Each step can identify new items required from previous steps, creating feedback through an interactive looping action.

2.3.1 NTW SRD Development Overview

A primary product of the NTW system requirements engineering process is an SRD. The SRD will address multiple requirements levels from the operational requirements at the Navy TBMD Mission Area, the NTW Mission Program and finally to the product programs. This process is illustrated in Figure 2-4 which shows the development of each section of the SRD at each step in the process as well as the formal reviews. While Figure 2-4 shows the SRD generically, the SRD will be developed to conform to the SRD format being developed by PEO(TAD)-SE.

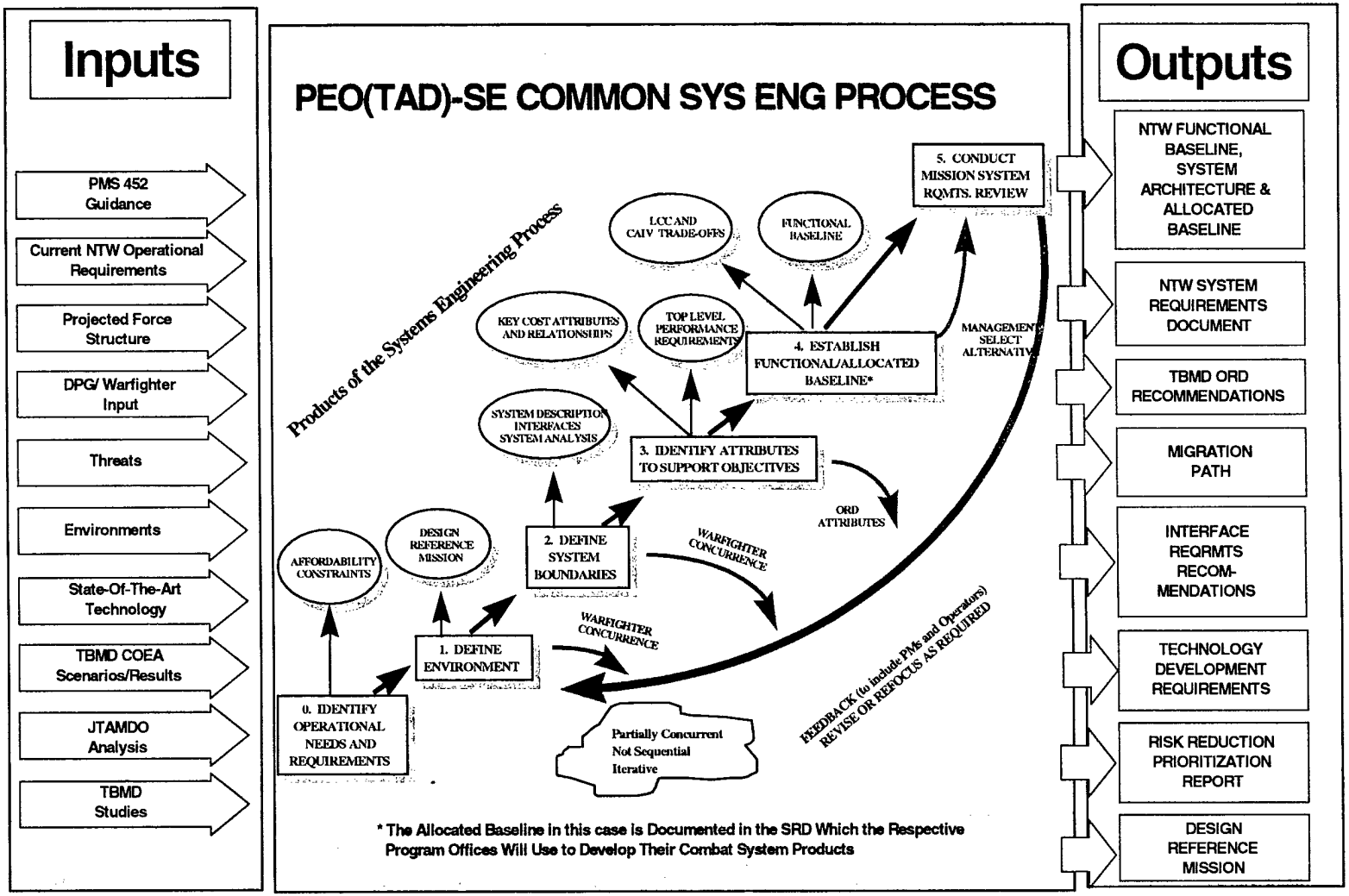


Figure 2-3. NTW System Requirements Engineering Process

	SRD	NTW SYSTEM ENGINEERING PROCESS					
		Step 0	Step 1	Step 2	Step 3	Step 4	Step 5
	Scope of the System			Initial Draft		Final	SRD Approval
	Threats/Environment	Initial Draft	Prelim.			Final	
	Operational Requirements	Initial Draft			Prelim.	Final	
Functional Baseline	NTW Functional Requirements			Initial Draft	Prelim.	Final	
	NTW Technical Performance/MOEs				Prelim.	Final	
	NTW Interface Requirements			Initial Draft		Final	
	NTW Verification Requirements				Prelim.	Final	
Allocated Baseline	Allocated Functional/Performance					Final	
	Interface Requirements					Final	
	Allocated Verification Requirements					Final	
	Reviews	ORR			CPBR	MSRR	

Figure 2-4. Development of the NTW Initial Draft SRD

2.4 STEP 0 – IDENTIFY OPERATIONAL NEEDS AND REQUIREMENTS

The purpose of this step in the system requirements engineering process is to collate and reconcile the top-level operational requirements and needs for NTW and the associated requirements for the systems involved.

Until recently, TBMD requirements had been governed by the Joint Requirements Oversight Committee (JROC) approved Capstone Operational Requirements Document (ORD), dated 9 Dec 1994. The Capstone ORD was comprised of both TBMD (Part I) and National Missile Defense and Global Defense (Part II). In late FY96, the decision for the document to be divided by distinct mission areas resulted in re-evaluation of the purpose and content. Presently, the draft of the new Theater Missile Defense (TMD) Capstone Requirements Document (CRD) includes all operational elements of theater missile defense - passive defense; active defense; attack operations and Command, Control, Communications, Computers and Intelligence (C^4I). A change in the philosophy now applies the document to TBMD, Cruise Missile Defense (CMD) and Anti-Ship Missile Defense (ASMD). The CRD identifies the overarching requirements for a family of theater missile defense systems to protect US forces, our allies, coalition forces, and critical assets in the theater against missile attacks. It is intended to guide the services in developing operational requirements documents for future theater missile defense systems and to facilitate development of interoperable systems. It will also provide a vehicle for the JROC to maintain oversight of the services' TMD programs. A formal coordination process is under way with a draft released for review in July FY97, Senior Warfighter Review in July FY97 and submission to JROC for approval in fourth quarter FY97. Similarly, the Naval TBMD ORD (dated 17 July 1996) is being revised to include the critical parameters for the NTW system which are incomplete in the current version. The anticipated schedule is for a draft to be submitted to JROC for approval during fourth quarter of FY97.

Figure 2-5 illustrates the existing top-level requirement documentation flow, starting with the TMD Capstone requirements and threats, and the organization of the NTW operational requirements and needs into a coherent hierarchical structure. It also illustrates that after initial identification, the requirements will be modified via feedback as the other system requirements engineering steps are performed.

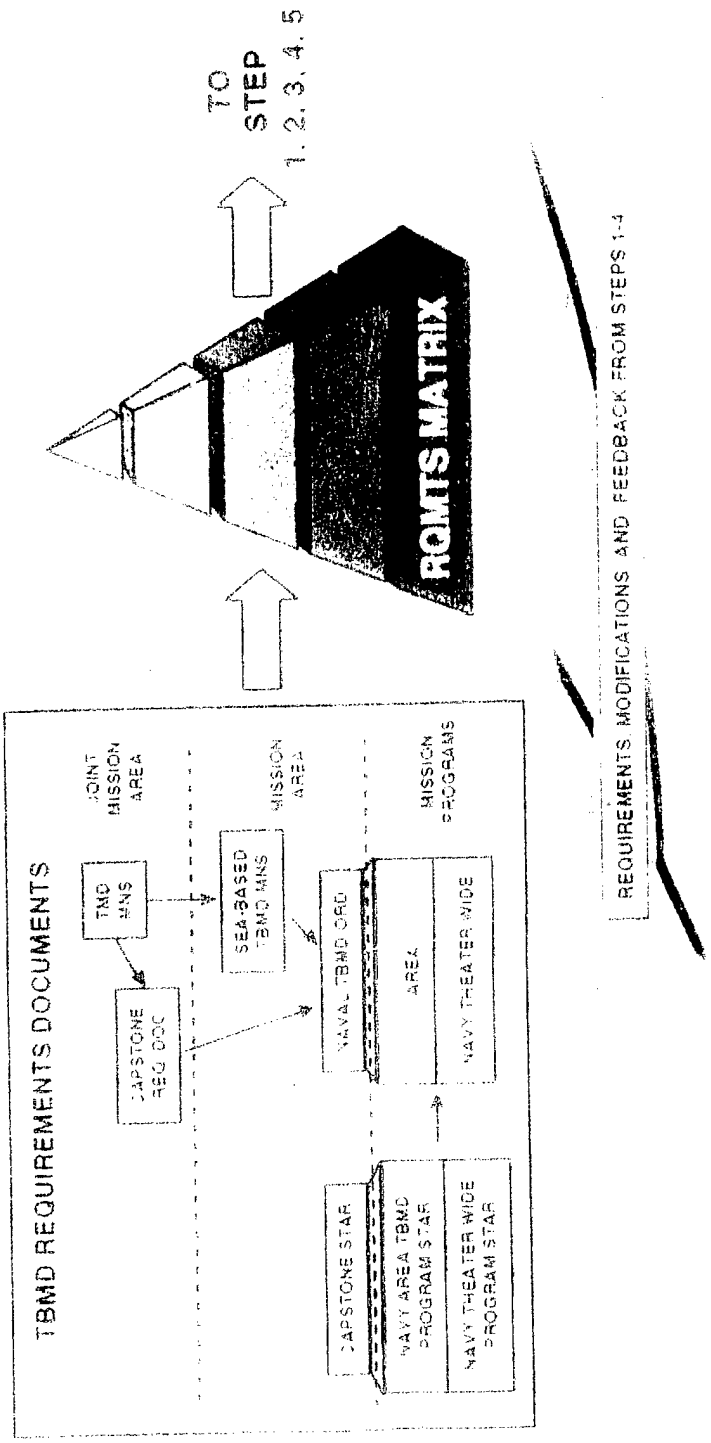


Figure 2-5. Identify Operational Needs and Requirements

Step 0 is intended to help answer the following fundamental questions to set the stage for the subsequent steps:

- What are the existing operational requirements, both Navy and Joint?
- What are the relationships between these requirements?
- What are the missing or conflicting decompositions from the top-level operational requirements?
- What are the affordability constraints that will bound the NTW solution? and
- What are reasonable inputs to the NTW Operational Requirements Document?

Figure 2-6 diagrams the process that will be used to answer the previous questions.

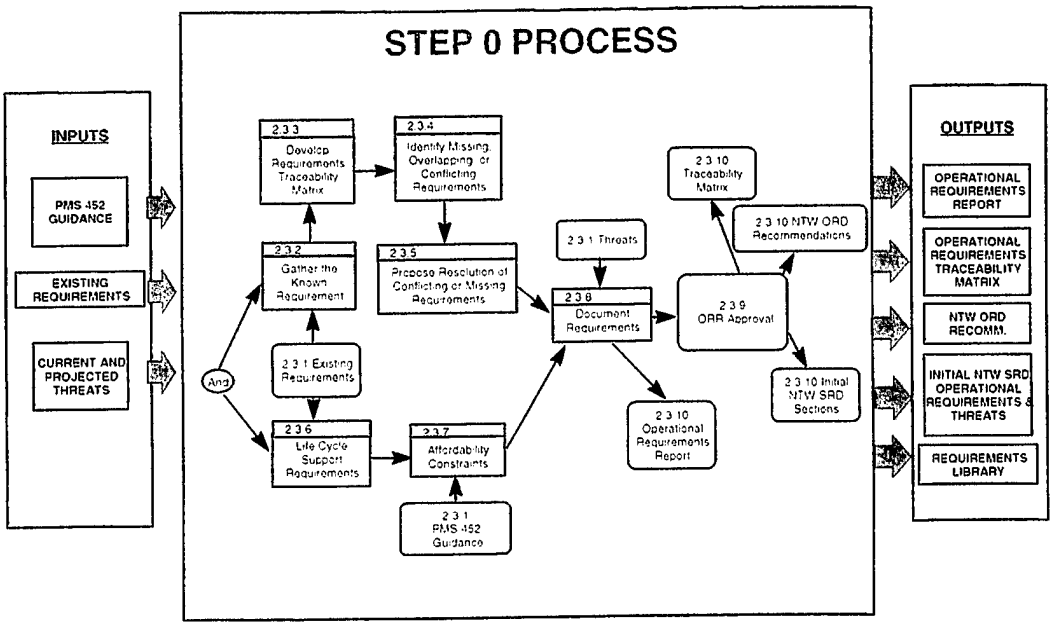


Figure 2-6. Identify Operation Needs and Requirements Process

2.4.1 Step 0 Inputs

- PMS 452 Guidance - General guidance will be provided by PMS 452.
- Existing Requirements - The primary input to Step 0 is the existing and projected top-level mission needs and operational requirements documentation derived from previous DoD, BMDO, and Navy studies and analyses. Core NTW systems are listed in Table 2-1 of Section 2.5.2.
- Threats - Threat information will be collected from multiple sources. The TMD Capstone Documents, Operational Requirements Documents (ORDs) and System Threat Assessment Reports (STARs) will be the primary source for general threat information. More detailed threat information will be obtained and coordinated with the recently formed PEO(TAD) and PEO SC Threat Cell and with the Joint Guidance and Policy Paper (JG&PP) #97-01.
- Feedback - Step 0 documents an initial set of operational requirements and establishes traceability. These requirements will be modified and further defined by Step 2 as the NTW boundaries are better defined by Step 3 as the key requirements are determined and finally by Step 4 as the requirements are allocated.

2.4.2 Gather the Known Requirements

Over the past several years the NTW operational requirements were derived from the Capstone Operational Requirements Document (ORD) which was preceded by the Mission Needs Statements (MNS) for TMD and Sea-Based TBMD. As stated in the introduction the Capstone ORD (now the Capstone Requirements Document) and Naval TBMD ORD are being reevaluated and new drafts are expected by the end of FY97. In addition to the official documentation, previous and ongoing studies have proposed operational requirements for NTW and even decomposed those to proposed operational requirements for the individual nomenclatured systems. For this effort all of the official and proposed requirements documents from overall mission area to nomenclatured system will be collected.

In addition to the TBMD operational requirements, the operational requirements for the systems associated with NTW will also be collected. For this effort the full traceability of the non-NTW operational requirements is not required. The requirements are collected for future reference for Step 2, 3 and 4. The list of systems effected must be coordinated with Step 2, which defines the boundaries and associated systems. The legacy system operational requirements and needs should be documented in individual ORDs or equivalent documents or specifications.

2.4.3 Develop Operational Requirements Traceability Matrix

Once the NTW related requirements are collected, they will be organized into an Operational Requirements Traceability Matrix that shows the decomposition, relationship and allocation from the TBMD MNS to the Naval TBMD ORD. Requirements will fall into three basic categories: quantifiable performance, functionality and interoperability/compatibility constraints. A Requirements Work Group of TBMD experts generate and manage the

operational requirements as well as resolving conflict and identifying missing requirements. The Requirements Work Group will be led by JHU/APL and made up of representatives from the organizations identified in Table 1-1.

To facilitate the development of the Operational Requirements Traceability Matrix an automated requirements tracking tool will be used. The requirements from each of the NTW related documents collected in Section 2.3.2 will be entered into a database to show the relationship between elements and higher level systems. Each requirement will be reviewed to determine the documented allocation and relationship to both upper and lower level systems.

2.4.4 Identify Missing, Overlapping, or Conflicting Requirements

After the explicit allocations and relationships are identified from the formal documentation, the entire Operational Requirements Traceability Matrix will be reviewed to identify and highlight problems and weaknesses which will be addressed in later steps of the system requirements engineering process. For example, the requirements stated at the TBMD (mission area) or NTW (mission program) may not have been allocated or decomposed to the BMC4I systems (product programs) requirements. The more likely situation is that the element level operational requirements will have numerous details that are not directly upwardly traceable. These additional requirements will be evaluated, not to determine if the quantified numbers are supportable, but to determine if they are indirectly decomposed from a higher operational requirement.

In addition to checking for missing traceability, the requirements will be reviewed for redundancies and conflicts as a result of the various studies decomposing the operational requirements differently.

2.4.5 Propose Resolution of Conflicting and Missing Requirements

To finish the development of the Operational Requirements Traceability Matrix, recommendations will be made to resolve the issues raised in Section 2.3.4. It is not the intent of Step 0 to perform detailed analyses and determine the final solution but rather to provide a reasonable starting point and document the assumptions that lead to the recommendations. As part of that documentation a list will be developed of the element interfaces, functionality and performance that need further definition and analysis. This list will be incorporated in the Steps 2, 3 and 4 studies and analyses as appropriate to verify and refine the proposed requirements.

The Requirements Work Group review will utilize a structured top-down process to review and assess the operational requirements and top-level functions. The Requirements Work Group will start with the TBMD mission area and identify the tasks involved and then further develop a set of operational requirements to perform the tasks. The results of the structured requirements review will provide insight into the missing requirements traceability and provide recommendations for additional operational requirements that can be incorporated until the detailed analysis is performed in Steps 3 and 4.

2.4.6 Life Cycle Support Requirements

To bound the scope of the alternative analysis performed in Step 4, the top-level support requirements will be identified. Without some reasonable understanding of these constraints considerable effort could be expended examining potential solutions that would ultimately be unsupportable. For NTW it is anticipated that the components of the system will be required to operate and be supported within the existing infrastructure and strategy. This effort will draw heavily on the existing Navy Area TBMD Cost Analysis Requirements Description (CARD) and the NTW CARD currently under development.

Since system support is a key factor in total system life cycle cost, the system mission support assumptions will be identified. It may be very difficult to identify a single philosophy since virtually the entire current system is fielded with a support structure already in place. At a minimum, the following elements of supportability shall be analyzed:

- Maintenance Planning
- Facilities
- Supply Support
- Support Equipment
- Packaging, Handling, Storage & Transportation (PHS&T)
- Training and Training Support
- Computer Resources Support
- Manpower and Personnel
- Design Interface
- Technical Data

2.4.7 Affordability Constraints

To bound the study options that need to be considered, affordability constraints will be developed. The affordability of the NTW System must be considered for a defined system life. Determining the total cost of the system will require more than a simple tabulation. For the legacy systems involved in NTW, the primary sources of affordability information are the POM budget and the program managers. For the new elements, the latest Navy plans and projections will be utilized. The budgetary estimates will include not only RDT&E and SCN costs but an estimate of the operational and support costs once the system is developed.

2.4.8 Document Requirements

The operational requirements and needs will be documented in the Operational Requirements Traceability Matrix which will show decomposition from the TMD MNS and TMD Capstone Requirement Document to the Naval TBMD ORD.

An Operational Requirements Report will be a companion report to the decomposition matrix and will be written to document the requirements issues that were discovered in Section 2.3.4 along with the rationale and proposed resolution of the issues developed in Section 2.3.5. The report will also include the life cycle support assumptions and affordability constraints developed in Sections 2.3.6 and 2.3.7.

The overall Navy requirements are included in the Naval TBMD ORD which has sections that describe the overall Naval TBMD system and then further details for the specific systems: Area, Marine Expeditionary and Theater Wide. The development of the Operational Requirements Traceability Matrix will provide insight into the completeness and consistency of the NTW requirements and allow the documentation of recommended changes and modifications to the NTW related aspects of the Naval TBMD ORD. This draft will only provide suggested requirements with placeholders for the quantitative parameters. The ORD recommendations will be updated at the completion of Step 3 and again after Step 4.

The NTW Mission Program operational requirements captured in this step will be documented in draft sections of the SRD. The threats and operational environment will also be drafted for inclusion in the SRD.

2.4.9 Operational Requirements Review

At the end of the previous steps the result will be a completed Operational Requirements Traceability Matrix that documents the operational requirements. Some entries will be fully documented and others will simply be recommendation with loose rationale. These are not intended to be the final NTW requirements but merely representative and complete enough to begin the more rigorous system requirements engineering analysis.

At the completion of Steps 0, Steps 1 and 2, an Operational Requirements Review (ORR) will be held. The Operational Requirements Traceability Matrix is the primary output of Step 0 that will be presented at the ORR. The details of the entire traceability matrix can not be reviewed at the ORR. The ORR will focus on the requirements issues, proposed resolutions with supporting rationale and a discussion of the additional analysis required. The ORR will be led by PMS 452 and jointly hosted by JHU/APL and NSWCDD. The participants in the ORR are identified in Table 1-1.

2.4.10 Step 0 Products

- Requirements Library - This library will not actually be a delivered product but rather a source for all of the related requirements documents including the requirements database. The library will need to be maintained and updated throughout the remaining steps;
- NTW Operational Requirements Traceability Matrix;
- NTW Operational Requirements Report;
- Draft recommendations for the Naval TBMD ORD; and

Initial draft of operational requirements and threats section of NTW SRD.

2.5 STEP 1 – DEFINE THE OPERATIONAL ENVIRONMENT

The purpose of this step is to define the Design Reference Mission (DRM) which details the operational environment within which the NTW system attributes and requirement allocations are evaluated. Accurate and complete specification of the DRM is required to support the evaluation of allocation alternatives and relative importance of design characteristics. The DRM will be the baseline used to evaluate the relative merit of proposed system concepts and upgrades for the Navy Theater Wide Mission Program.

The DRM will be constructed to represent the operational environment circa 2010. This timeframe has been selected since it is several years past the scheduled NTW BLK II deployment date. It is unreasonable to assess a full campaign involving NTW combat forces at the time of first deployment because sufficient numbers of NTW equipped ships, equipment and logistics support would not be available.

The DRM will define the campaign at several levels as illustrated in Figure 2-7. The individual engagements will be defined in detail to enable evaluation of individual system performance. Multiple engagements will be combined into Operational Situations (OPSITS) which will be used to evaluate NTW systems in the broader context of a Joint Task Force. The OPSITs will then be combined into a full joint force theater wide campaign. The DRM is an engineering tool that will be used in the evaluation of the NTW System to stress all aspects of the system from performance and functionality to interoperability and supportability.

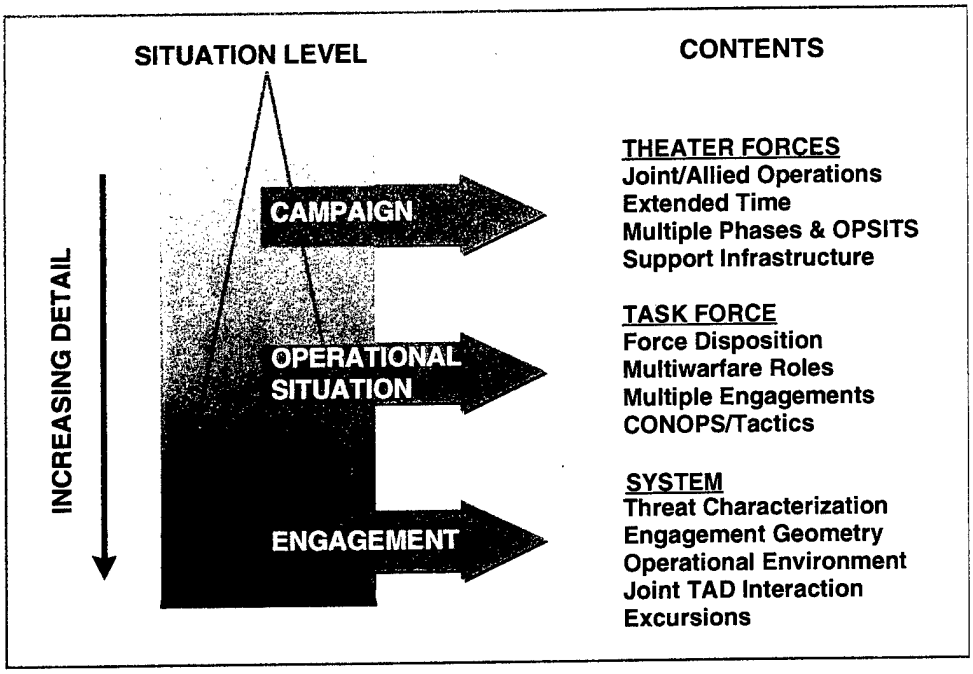


Figure 2-7. DRM Domain

Figure 2-8 shows that the DRM will be more than a single event with specific threats. The DRM will define the total envelope of the operational environments in which the NTW System must perform from the early stages of initial presence to the end of hostilities. For NTW it is important to evaluate the contribution of the Navy TBMD System when the Navy is first in theater and also after other TBMD systems are in place.

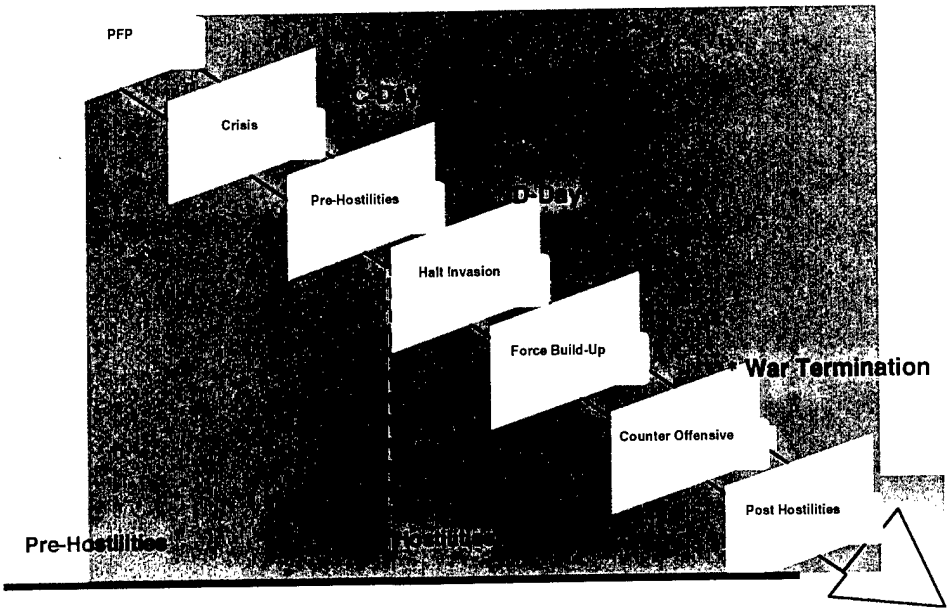


Figure 2-8. DRM Total Envelope

The DRM will consist of politically and geographically generic OPSITs with specific representative threats. The DRM will specify the entire operational environment not just the threats, raid sizes and timing. This will include the physical phenomena such as clutter and propagation effects as well as EW and system availability. The DRM will contain the necessary features and details to evaluate each of the requirements from the Operational Requirements Traceability Matrix.

In addition to the development of the DRM, Step 1 will answer the following fundamental questions to focus the subsequent steps and establish a clearer understanding of the operational environment that needs to be modeled:

- What specific OPSITs will be evaluated?
- For what combination of OPSITs will the NTW design be optimized?
- What is the temporal and spatial disposition of theater assets?
- What Concept of Operations (CONOPs) and Rules of Engagement (ROEs) will be assumed for each OPSIT?
- What are the design driving characteristics of the threats and situations that stress the NTW System and enable the evaluation of:

- Ability to engage the threat;
- Extent of the protected battlespace;
- Availability of the system;
- Training required to fight effectively;
- Risk of incorrect engagement decision; and
- Impact of force structure and operational concept.

Figure 2-9 shows the input to Step 1 and the process that will be executed to develop the outputs.

JHU/APL will lead the development of the DRM with major involvement by NSWCDD. Two work groups will be established to support the development of the DRM. The Engineering Work Group will be comprised of TAD analysts and design experts. The Engineering Work Group will be responsible for identifying the driving characteristics to adequately evaluate each aspect of the NTW System. The Operational Work Group will include warfighters with experience in defining and executing the related TAD missions. The Operational Work Group will provide guidance and review of the CONOPs, ROEs, and operational situations to ensure that the DRM is truly representative of naval and joint force evolutions. Both work groups will be led by JHU/APL and the participants are identified in Table 1-1. JHU/APL will be responsible for the coordination and passing of information from the work groups for incorporation into the DRM.

2.5.1 Step 1 Inputs

- Operational Requirements – An initial version of the NTW operational requirements being identified in Step 0 are required to properly reflect the mission of the system and develop the DRM.

- Elements from previously developed scenarios, DRMs and related program evaluations which are:

  - Mission Profile
  - Force Structure
  - Threats
  - Environment

- Functional Descriptions - The definition of the top-level functions will be developed in Step 2 in parallel with the DRM definition. An understanding of the top-level functions is required to ensure that the proper characteristics are included in the DRM to evaluate all aspects of the system.

2.5.2 Review Existing Scenarios at the Theater and System Level

Previously developed and approved OPSITs and detailed engagement scenarios will be evaluated from past and ongoing TBMD related analyses. The OPSITs will be evaluated to determine whether they include characteristics needed to exercise the full NTW functionality. The OPSITs will also be reviewed to determine the level of non-TBMD characteristics that are included for determining the impact of resource utilization.

2.5.3 Review and Identify CONOPs and ROEs

The recently developed Navy TBMD CONOPs will reviewed in the context of the scenarios identified in Section 2.4.2. The required changes and additions to the CONOPs will be developed to describe the command and communication structures with sufficient detail to enable accurate modeling and analysis of the situations identified above. ROEs that have been utilized in the past during similar situations will be obtained for each of the general phases of the DRM from pre to post hostility and reviewed for possible variations. While the ROEs may not significantly impact the TBMD response, they will impact the resource utilization and response for systems that also perform non-TBMD functions. The Operational Work Group of warfighters and systems engineers with NTW experience will be utilized to provide guidance and review of the CONOPs and ROEs.

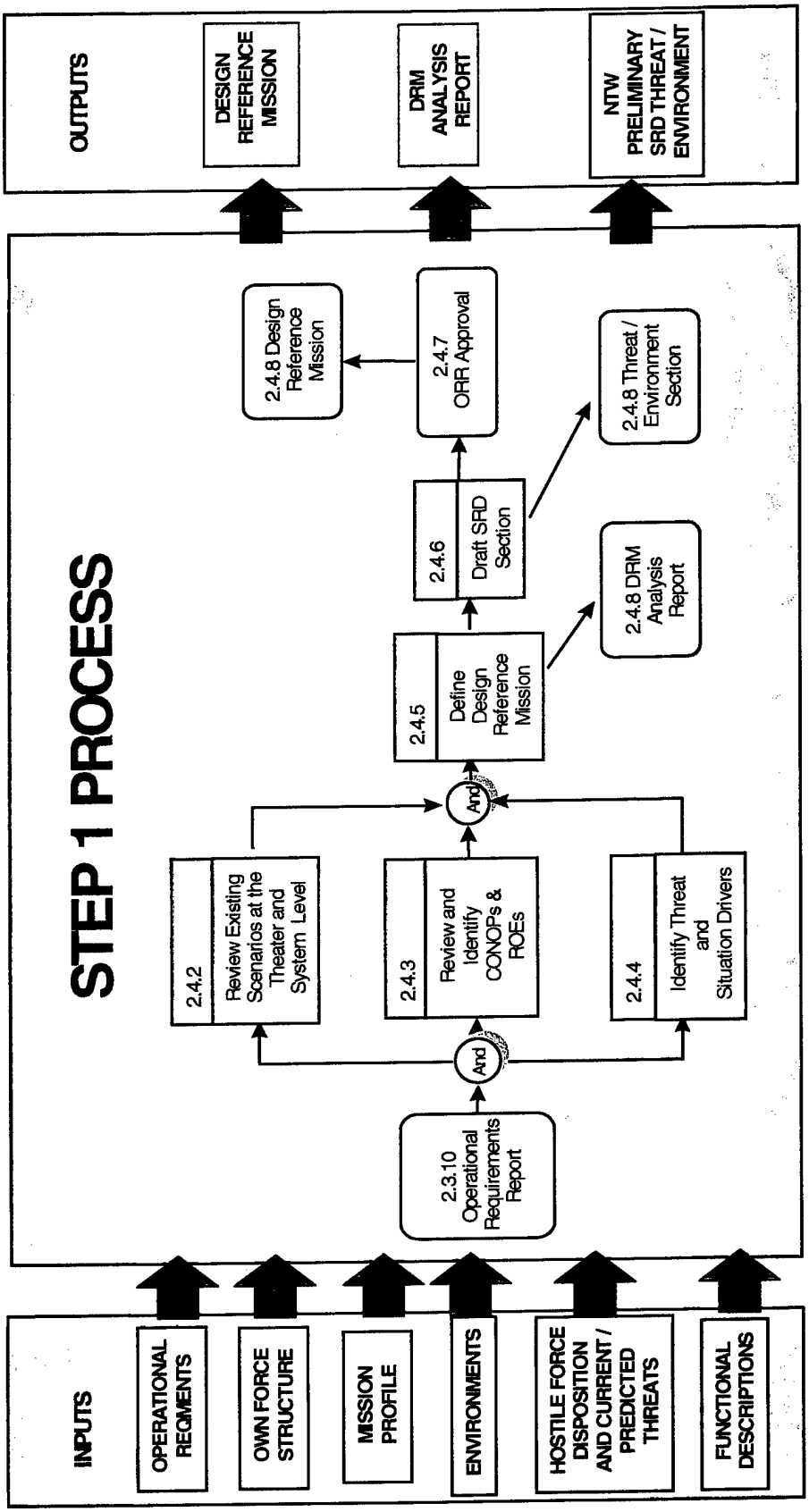


Figure 2-9. Define Operational Environment Process

2.5.4 Identify Threat and Situation Drivers

The Engineering Work Group of TBMD experts, will review the OPSITs, CONOPs, ROEs and threat documentation to determine the characteristics which most significantly impact the overall performance of the NTW System. Once the Engineering Work Group has determined a preliminary set of system drivers, a correlation with the composite functional description of the system being developed in Step 2 will be performed. The purpose of the correlation is to determine if each of the top-level functions will be evaluated with the selected set of drivers. These performance drivers will be organized into logical groupings and quantifiable limits or boundaries will be documented.

2.5.5 Define Design Reference Mission

spectrum of operational situations to enable accurate modeling without providing additional information that has little or no impact on the real world system performance. Incorporating factors that impact real world performance (factors that traditionally have not been incorporated in the analysis of individual systems) is the challenge in developing the DRM. Impacting factors to be considered include dynamic adversary response, reactive threats and timeliness of intelligence.

A single document will be developed which details the mission timeline, threat characteristics and OPSITs to adequately evaluate the NTW System in the context of a joint force campaign. The DRM will be put under interim configuration management after the internal review and full configuration management and control will be put in place following the ORR.

A DRM analysis report will be written which includes the details of the analysis performed and rationale used to develop the DRM. This report will also include sufficient traceability from approved originating documents to the various DRM components.

2.5.5.1 Threat Selection and Definition

A key characteristic of the DRM is the threat representation. For the NTW evaluation the primary threats are theater ballistic missiles which have been defined in the Capstone STAR with a NTW appendix currently being drafted for the FY98 DAB . The TBMD definitions have been extensively studied by the TBMD COEA and are currently being coordinated by a Threat Steering Group being led by PEO(TAD)-SE/CM.

In addition to the TBM threats, the DRM must include some basic definition of other threats, aircraft and anti-ship missiles, that impact resource utilization. However, unlike the TBM threats, these other threats will not be extensively defined since system performance is against these threats is not being evaluated by this study.

The evaluation and selection process for all of the threat types must consider the likelihood of encountering the threat and the unique characteristics of the threat which stress the

performance or functionality of the NTW System. Performance and functionality excursions, such as countermeasures or enhanced capability, will be defined as needed to thoroughly evaluate NTW performance.

As the threats are selected for inclusion in the DRM, the available threat documentation must be reviewed by the engineering IPT to determine if the proper level of characterization is available. The level of characterization may vary significantly depending on the threat type and analysis tool that will be used. For example, the general sensitivity analysis performed in Step 3 with the force-on-force model will require far less detail than the engineering models that may be used for specific system level evaluations. The detailed characterization required includes but is not limited to: trajectory, radar and EO signature, countermeasures, vulnerability to hard-kill and soft-kill. For those threats about which limited detail is available, the missing characteristics will be developed as required.

2.5.5.2 Mission and OPSIT Description

A sequence of OPSITs will be defined at the various phases of the campaign that stress the various aspects of NTW in the context of joint TBMD. The OPSITs will include non-TBMD threats and features at a lower, but sufficient, detail to enable an assessment of the utilization of systems that support other mission programs. The DRM will also include details on the overall campaign, such as force structure, ship deployment cycle, and support system assumptions, to enable evaluation of availability and maintainability.

The operational requirements and driver characteristics will serve as a cross-check to ensure that the OPSITs encompass the bounds of NTW.

To provide a complete description, the DRM will contain information concerning all aspects of the campaign:

- Geopolitical Situation
- Overview of Adversary
- Overview of Joint Force
- Campaign Phases and Timeline
- Detailed OPSITs

Each detailed OPSIT will provide the information required for modeling and simulation of the NTW System performance:

- Adversary Definition
  - Force Disposition
  - Raid Composition
  - Threat Characteristics
  - Counter Measures
- Joint Force Definition
  - Force Disposition
  - CONOPs and ROEs
- Neutral Definition
  - Background Air Traffic
  - Background Surface Traffic
- RF Environment
  - Background Emitter Environment
  - Electro-Magnetic Enironment
- Natural Environment
  - Topography
  - Weather
  - Propagation Effects
  - Clutter

Variations or excursions will be defined in the DRM to enable the evaluation of system performance in 2010 and will reflect changes in threat characteristics, population and the introduction of new or improved own force assets.

2.5.6 Preliminary NTW SRD Threat/Environment Section

At the completion of Step 1, a summary of the NTW threat and operational environment developed for the DRM will be documented for incorporation into the NTW SRD.

2.5.7 Operational Requirements Review

A review of the draft DRM will be conducted with the members of both work groups and NTW management to obtain final comments and agreement on the content. The formal review and approval of the DRM will be performed at the Operational Requirements Review (ORR).

2.5.8 Step 1 Products

- Design Reference Mission;
- Preliminary NTW SRD Threat/Environment Section; and a
- DRM Analysis Report

2.6 STEP 2 – DEFINE SYSTEM BOUNDARIES

The intent of this step in the system requirements engineering process is to describe the functions to be performed by NTW TBMD and the boundaries and interrelationships of NTW and its subsystems with other Joint Theater Warfare systems and subsystems. This step will document NTW interfaces and information flow and identify areas where functional relationships cross system boundaries and may result in potential performance sensitivities. See Figure 2-10. The NTW System is in the center box with external interfaces depicted around it.

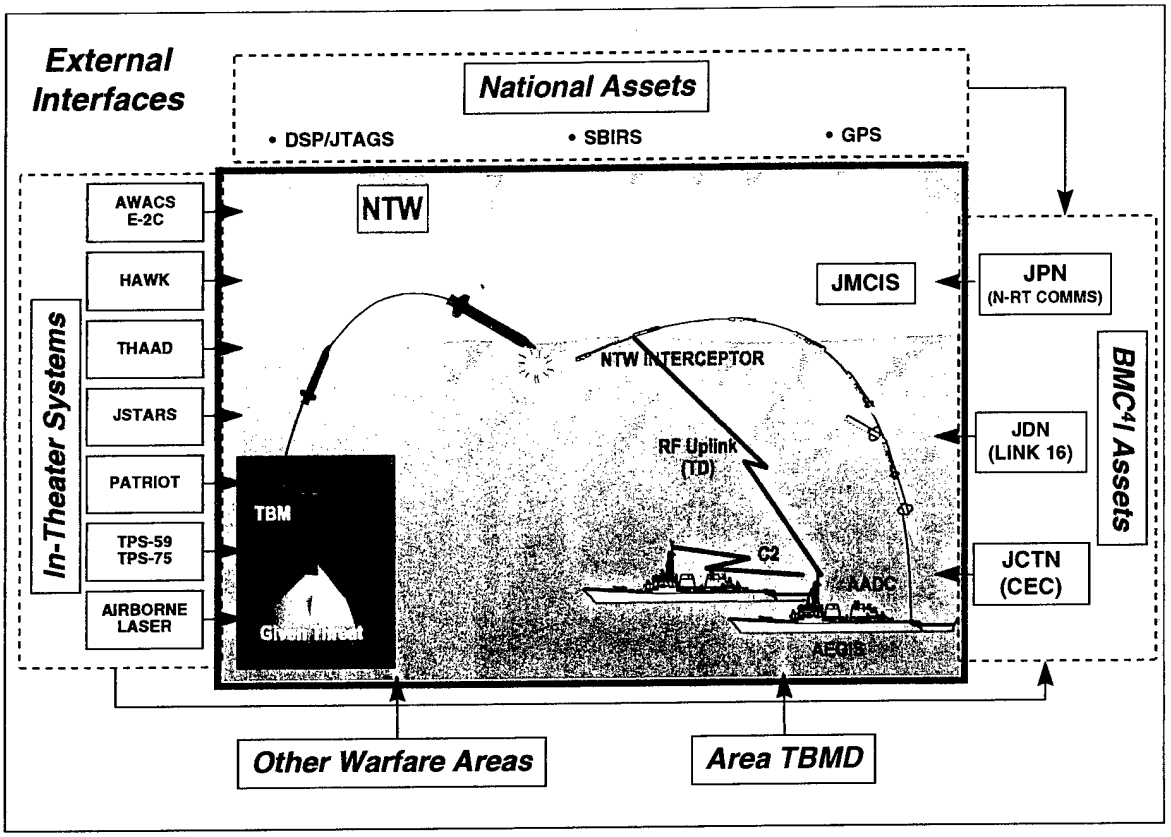


Figure 2-10. NTW System Boundaries

At this stage of the engineering process the intent is not to constrain the allocation of specific new NTW derived functionality but: (1) to understand and document the functionality required to conduct NTW, (2) to understand the physical and functional relationships between current subsystems that will be included in NTW and (3) to understand and document the interfaces and functional interrelationships between NTW and other Joint and Navy Air Defense related systems, as well as national assets. An overall product of this step will be a descriptive hierarchical "functional description" of NTW embedded in a system engineering tool database. The database will include functional descriptions, intra and intersystem interfaces, boundaries and functional flow diagrams. Functions performed by interfacing systems will also be included when they impact on the conduct of NTW. The database will also include key NTW related performance characteristics of those current subsystems that will be included in NTW. The

functional description developed in this step will address the full set of operational requirements coming out of Step 0 and will provide the basis for identifying functions not currently being performed by existing systems. This step provides an input to the development of system alternatives to be performed in Step 4.

Figure 2-11 provides an overview of the system requirements engineering processes to be carried out in Step 2. This step is intended to answer the following questions:

- What are the boundaries of the "NTW System"?
- What are the current subsystems that will be part of NTW and what NTW related functions do they currently perform? What are their key performance characteristics that relate to the conduct of NTW?
- What are the NTW internal and external interface requirements and characteristics?
- What are the interoperability requirements?
- What are the NTW related functions that must be performed?
- What are the relationships and interfaces between those functions?

This step will build on Area and NTW efforts and studies that are underway or have been conducted to date. This step will be led by JHU/APL with support from NSWCDD, NTW element system engineers and other participants as defined in Table 1-1.

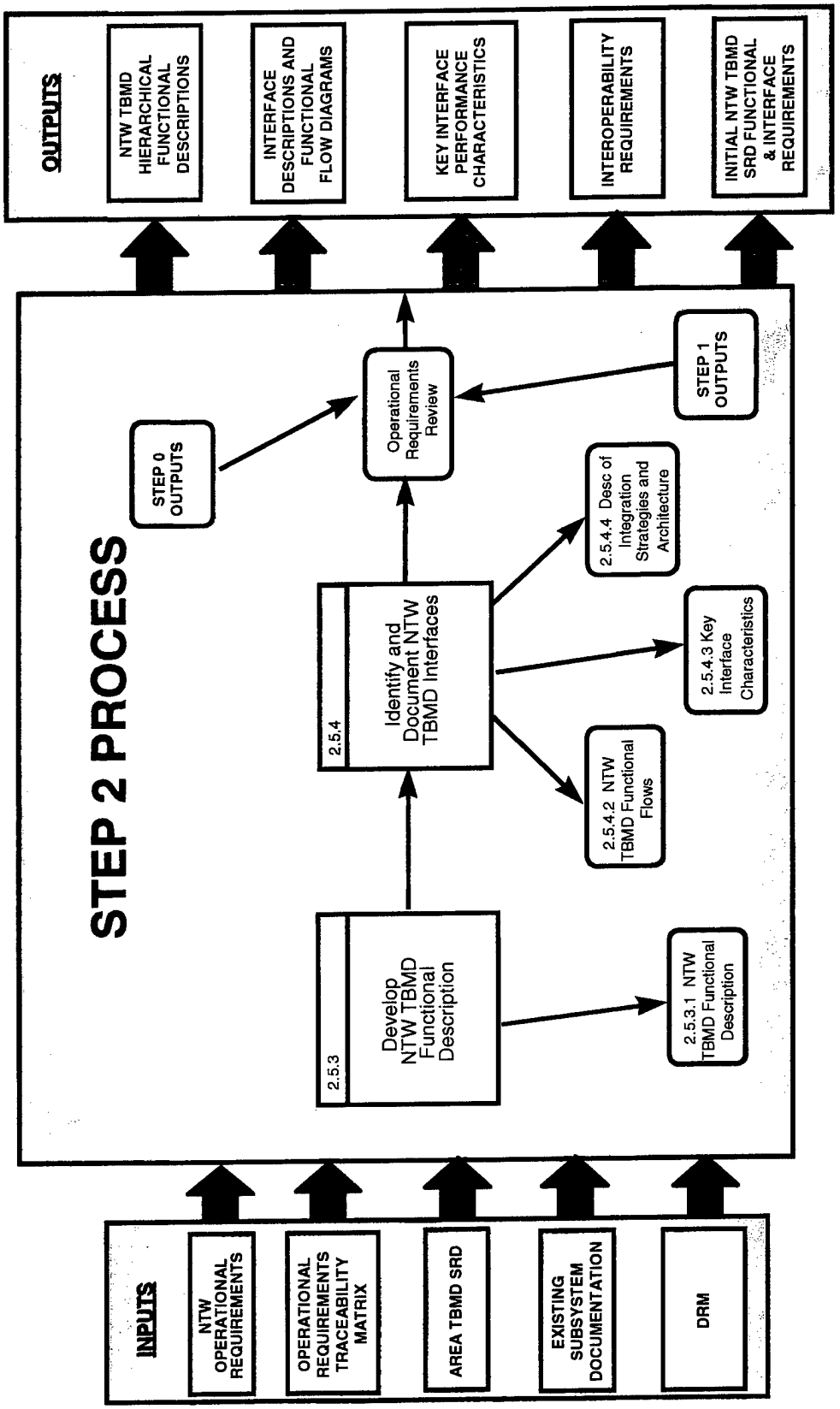


Figure 2-11. Define System Boundaries Process

2.6.1 Step 2 Inputs

As depicted in Figure 2-11, the major inputs to this step are as follows:

- Operational Requirements Report from Step 0;
- Operational Requirements Traceability Matrix from Step 0;
- Area TBMD System Requirements Document;
- Existing subsystem documentation; and
- DRM from Step 1.

2.6.2 Systems to be Addressed

This step will address all nomenclatured systems that play either a direct or significant indirect role in Navy Theater Wide TBMD. The Navy Theater Wide TBMD capability will be built on that developed for Area TBMD. In addition, many of the nomenclatured systems that are elements of NTW support other non-NTW Air Defense functions. These non-NTW Air Defense functions contribute to the environment in which NTW is conducted and in many cases compete for resources when executing NTW. To the degree that these functions impact NTW they will be included as part of this system requirements engineering effort. Likewise all interfacing systems that may substantially impact on NTW (e.g. cueing, positioning, C^3, tracking etc.) will be addressed. Core NTW elements are listed in Table 2-1. Interfacing subsystems are given in Table 2-2.

Table 2-1. Core NTW Elements

AEGIS Weapon System (As modified for Area and NTW):
AN/SPY-1 - modified for TBMD
AEGIS Command and Decision (C&D)
AEGIS Weapons Control System (WCS)
AEGIS Fire Control System (FCS)
AEGIS Display System (ADS)
AEGIS Combat Training System (ACTS)
AEGIS Operational and Readiness Test System (ORTS)
Vertical Launch System (VLS)
NTW Interceptor
High Power Discriminating Radar*
Concentric Canister Launcher (CCL)*
SPY-2*
SEA ATHENA*
BMC^{4}I :
Exterior Communication System (EXCOM)
Joint Tactical Information Distribution System (JTIDS/Link 16) - Joint Data Network (JDN)
LINK-11
TRAP/TRE
Joint Maritime Command Information System (JMCIS) - Joint Planning Network (JPN)
CEC - Joint Composite Tracking Network (JCTN)
Shipboard AADC- Area Air Defense Commander
Tactical Data Distribution System (TDDS) - Replacement for Trap/TRE

*** Potential New Development Item**

Table 2-2. Interfacing Systems

Other Shipboard Systems:
JMCOMS (Joint Maritime Communications)
SM-2 Block IVA - Area Defense Interceptor
TIMS - TFCC (Tactical Flag Command Center) Information Management System
BMC4I:
Global Command and Control System (GCCS-M) - Shipboard connectivity via JMCIS
Tactical Information Broadcast System (TIBS)
National Sensor Support:
Defense Support Program (DSP)
Space Based Infrared System (SBIRS-HEO)
Space Missile Tracking System (SMTS/SBIR-LEO)
Global Positioning System (GPS)
IN THEATER SYSTEMS:
THAAD
JSTARS
Patriot
Hawk
TPS-59
TPS-75
E-2C
AWACS
Airborne Laser

2.6.3 Develop NTW Theater Ballistic Missile Defense Functional Descriptions

2.6.3.1 Develop Functional Descriptions of NTW

The objective of this substep is to produce a functional description of NTW. A database that contains hierarchical functional definitions of the systems that are elements of NTW will be developed. This functional description will only address functions that are directly related to NTW or impact NTW related resources. These functional descriptions will be drawn from existing system documentation, the Area TBMD SRD and a functional decomposition from the operational requirements defined in Step 0. This functional description will form the basis for the establishment of performance requirements in Step 3 and the allocation of functions and performance to individual elements to be done in Step 4. The functional decomposition will only go to that level required to clearly define the key functional and performance requirements to be allocated to these elements and to understand the role each element plays in overall NTW.

2.6.3.2 Document Current Performance Characteristics of NTW Subsystems

Since NTW will encompass modifications to elements of the AEGIS Weapon System it is important to understand how those elements perform in areas related to NTW. NTW related performance characteristics will be abstracted from existing documentation and inserted in the

database. Emphasis will be on those characteristics that are visible to other elements of NTW and that impact on overall NTW performance. In addition to these performance characteristics, key compatibility and interoperability characteristics will also be abstracted and added to the database.

2.6.4 Identify and Document NTW Interfaces

This section addresses the functional definition of the interfaces between NTW subsystems and between NTW and non-NTW elements as well as the strategy and architecture used to integrate the various NTW subsystems. This section has four main elements:

- The identification of external interfaces and the addition of interfacing systems to the functional database.
- The addition of functional interface information to the database;
- The identification of key performance characteristics for interfaces that are potential "stress" points in terms of performance; and
- The documentation of interoperability requirements.

2.6.4.1 Develop Functional Descriptions of Systems that Interface to NTW

External interfaces will be identified and the functional database built in the proceeding section will be expanded to include those Navy and non-Navy systems that support and interface with the systems that make up NTW. The emphasis will be placed on those aspects of these systems that contribute to TBMD and those which compete for resources that are used in conducting NTW.

2.6.4.2 Develop Interface Descriptions and Functional Flow Diagrams

Functional interface descriptions and functional flow information will be added to the database developed in Section 2.5.3. The database will link the interface data flow to originating and receiving subfunctions as well as originating and receiving elements. The database will include both intra-NTW interfaces and interfaces to non-NTW systems and will be used for interface and functional analysis. An analysis will be conducted to identify situations where an NTW related function is closely coupled to a function in a non-core NTW element or to a new or modified function in a core NTW element and that function is sensitive to changes in the interface or implementation of the interfacing function. These areas will be noted for subsequent analysis in Step 4.

2.6.4.3 Identify Key Interface Performance Characteristics

A report will be developed that identifies key NTW interface requirements. Interface performance characteristics that stress or significantly impact performance such as data link reporting latency will be identified and included in the database.

2.6.4.4 Identify Interoperability Requirements for Integration of NTW with Other Systems

This substep focuses on the requirements for integrating NTW with non-core NTW systems. The objective of this substep is to develop an understanding of the current integration strategies being used and their implications on interoperability, life cycle cost and system performance. Current interoperability and interface standards and protocols that govern interfaces between NTW and other systems will be identified. When practical, existing documentation will be summarized and referenced rather than generating new descriptions. Potential system bottlenecks resulting from interfacing architecture or techniques that may impact overall NTW performance will be identified. NTW related databases that are used by more than one system shall also be identified and documented.

2.6.5 Update Functional and Interface Description Based on Steps 3 and 4

It is anticipated that the functional and interface description will be modified after Steps 3 and 4 as functions are restated and repartitioned to better reflect the need for the allocation of performance to functions and subfunctions, and functions and subfunctions to elements.

2.6.6 Step 2 Products

The following products will be produced by this step:

- NTW Hierarchical Functional Descriptions;
- Interface Descriptions and Functional Flow Diagrams;
- Key NTW Interface Performance Characteristics;
- Description of Interoperability Requirements; and
- Initial Draft of the Scope, Functional and Interface Requirements for the SRD.

The products of this step and those of Steps 0 and 1 will be reviewed at the ORR.

2.7 STEP 3 – IDENTIFY SYSTEM/SUBSYSTEM ATTRIBUTES THAT SUPPORT HIGHER LEVEL SYSTEMS

The objective of this step is to identify the key NTW system and subsystem attributes that significantly contribute to the successful completion of the TBMD mission and to translate these findings into a Conceptual Performance Baseline comprised of top-level functional and performance requirements.

Step 3 is designed to identify the critical NTW functions and their key attributes that contribute to warfighting success and to begin the iterative process necessary to incorporate risk and affordability into the Conceptual Performance Baseline (CPB). Figure 2-12 shows that a balance of cost, schedule, and performance are important considerations in defining NTW requirements and capabilities.

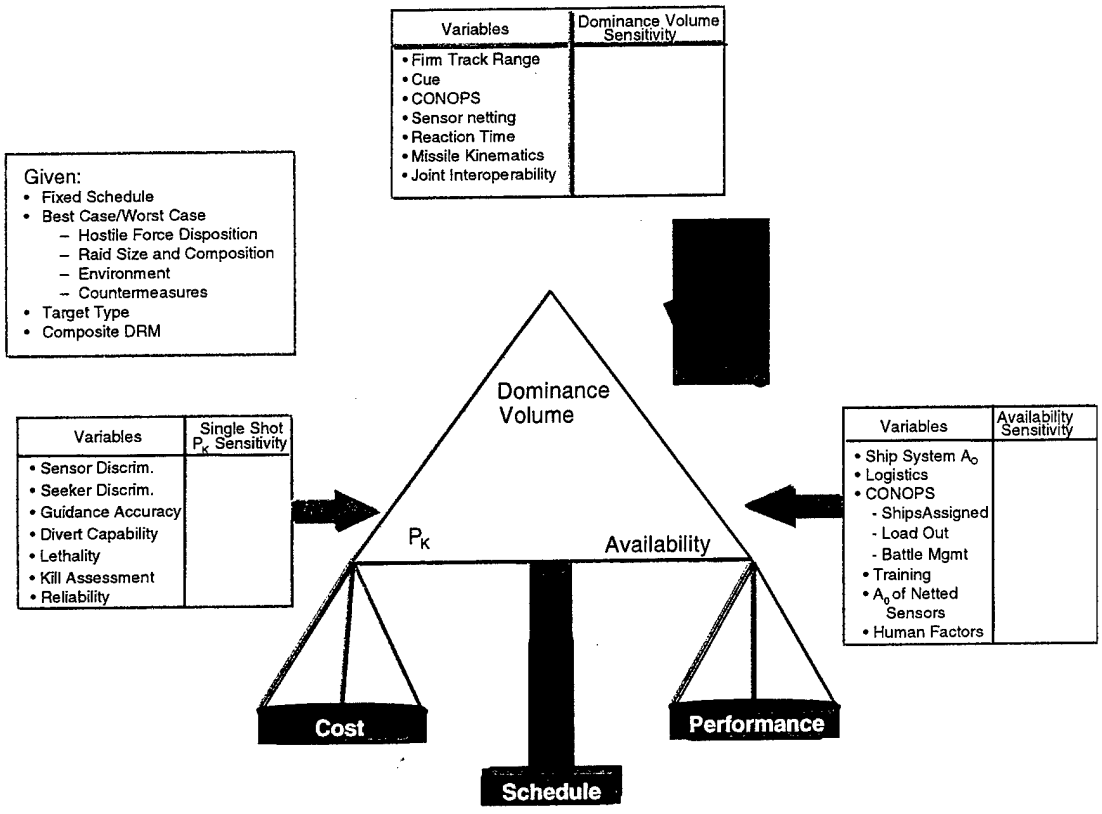


Figure 2-12. NTW Candidate Key Attributes

The Conceptual Performance Baseline developed in this step will be used in Step 4 to establish the NTW Functional and Allocated Baselines, including the functional and performance requirements for NTW subsystems (nomenclatured systems). Figure 2-13 shows the process required to develop the CPB.

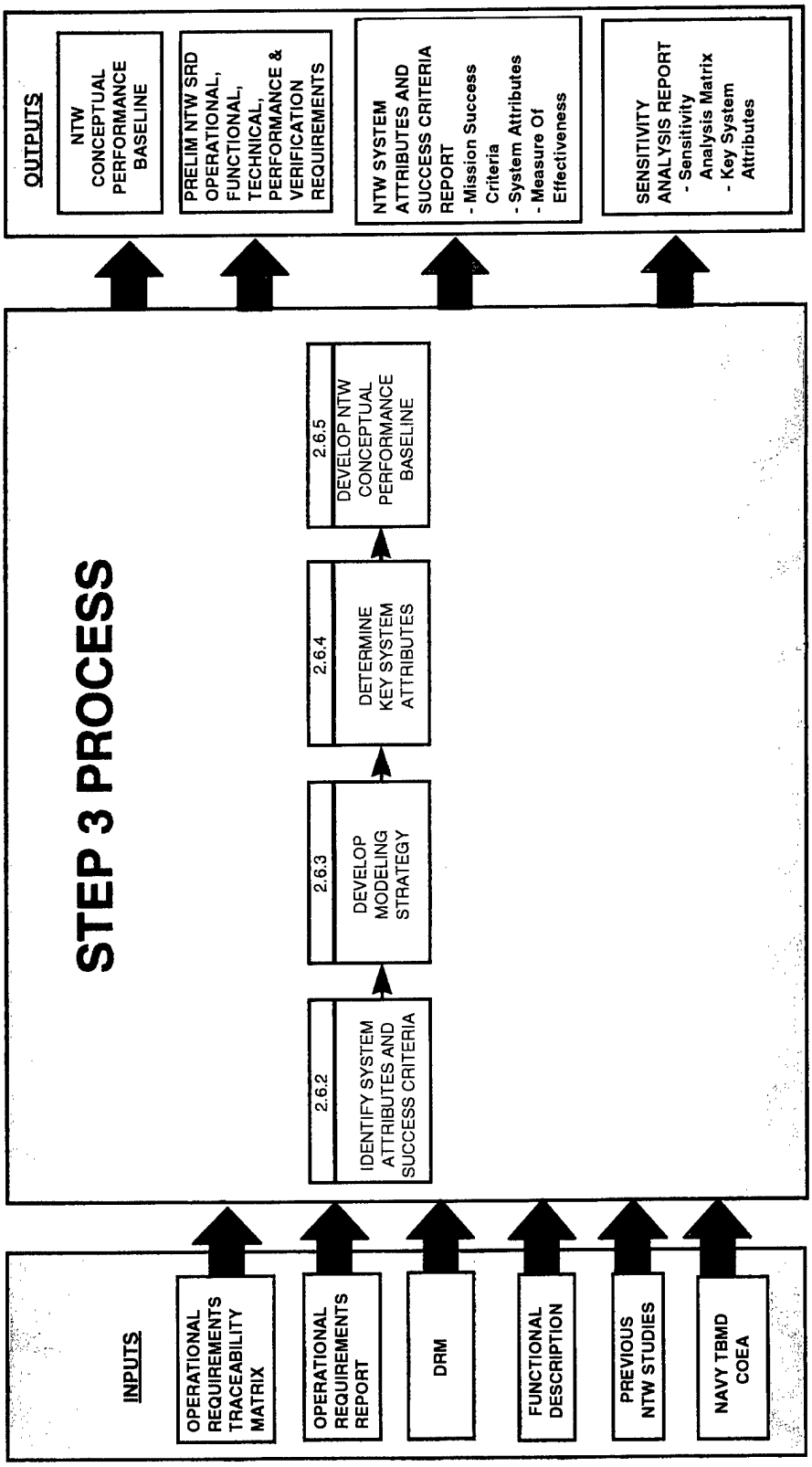


Figure 2-13. ID System/Subsystem Attributes Process

Key questions this step is designed to answer include:

- What are the key attributes and associated performance measures of the NTW critical functions?
- How do potential affordability constraints affect NTW mission success?
- What are the top-level NTW system functional and performance requirements, which are critical to ensure that the Mission Success Criteria (MSC) is met?

2.7.1 Step 3 Inputs

As shown in Figure 2-13, Step 3 requires several key inputs from previous steps. These inputs include:

- Operational Requirements Traceability Matrix - The Operational Requirements Traceability Matrix, generated in Step 0, will provide the starting point to begin the requirements iteration process;
- Operational Requirements Report - The Operational Requirements Report generated in Step 0 documents requirements issues and their resolution;
- Design Reference Mission - The Design Reference Mission developed in Step 1 provides the design stressing composite scenarios to be used in analyses identifying critical functions and key attributes;
- NTW Functional Description - The Functional Description of NTW developed in Step 2 will provide the basis from which critical functions and their attributes will be identified;
- Previous and ongoing TBMD studies; and
- Navy TBMD COEA Phase II.

2.7.2 Identify System Attributes and Success Criteria

A set of NTW system attributes which are critical to the Joint TBMD mission success will be identified by collecting, organizing, and agreeing upon data derived from Steps 0 through 2 of this plan. It is essential that data be included from previous and ongoing NTW studies as well as the Navy TBMD COEA Phase II. In order to determine which attributes represent the key system attributes, success criteria must be developed to determine the impact an attribute has on the NTW System's contribution to the Joint TBMD mission. These attributes will then be assessed to determine their contribution to system performance through a modeling and simulation process. An NTW System Attributes and Success Criteria Report will be generated to document the results.

2.7.2.1 Identify Mission Success Criteria

MSCs are defined as standard outcomes for which a defense success can be credited. NTW mission success is defined by how well a set of assets are defended.

2.7.2.2 Identify System Attributes

System attributes are defined as NTW system characteristics which can be organized into various categories such as functions, constraints, performance parameters, cost, physical characteristics, supportability and availability.

A structured process will be used to take previously developed top-level requirements and functional descriptions developed in Steps 0 and 2 and identify the most critical functions and system attributes. These critical functions and system attributes will then be used as inputs for the modeling identification and analyses in Sections 2.6.3 and 2.6.4. Examples of NTW system attributes are:

- V_{BO} (Burn Out Velocity);
- Discrimination;
- Detection/Track range;
- Minimum intercept altitude;
- Cueing accuracy and latency;
- Kill assessment;
- Attributes to support interoperability;
- Lethality; and
- System response time.

2.7.2.3 Identify Measure of Effectiveness

Measure of Effectiveness (MOE) is defined as characterization of battle outcomes related to MSCs. MOEs define parameters which can be used to measure the effectiveness of various system attributes. An initial list of MOEs will be determined by guidance from previous and ongoing NTW studies and by the Navy TBMD COEA Phase II. MOEs are used to quantify the results of analysis performed in Section 2.6.4. Examples of NTW MOEs include:

- Probability of Negation (P_N);
- Battle space;
- Forward defended range;
- Rear defended range;
- Cross range;
- Raid rate capacity;
- Engagement altitude;
- Minimum closing velocity; and
- Depth of fire.

2.7.3 Develop Modeling Strategy

System attributes defined in Section 2.6.2 will be assessed through the use of a modeling strategy. A modeling strategy must be developed for both performance and cost models including identification of the most appropriate models or level of models. Assessments will be made at the appropriate time to determine which existing models would meet the minimum requirements for the respective aspect of the analysis. A spectrum of models will be needed to address the entire system as well as critical functions and attributes, i.e., different levels of detail. However for this step, one-on-one and force-on-force level models with medium fidelity are of prime interest with others used only as required. Step 4 will require extensive use of engineering level models, as well as force-on-force, and these will be addressed in that section of this plan. Models currently being used and accepted in the NTW and Joint community will be the primary candidates for this step.

2.7.3.1 Model Availability / Suitability

Many detailed models of the nomenclatured NTW subsystems exist and a selected subset of these will be used in Step 4. However, there are very few models capable of sensitivity analyses at the NTW level in the full joint theater warfare context. The Extended Air Defense Test Bed (EADTB) and the Extended Air Defense Simulation (EADSIM) are the preeminent of these. EADSIM has been widely used for various force-on-force applications, but lacks model implementation flexibility at the user level. EADTB which is just now becoming fully operational provides a much better user modeling environment. Furthermore, recent Navy efforts with EADTB have led to the development of Area Wide and NTW models in this joint model. Similar models in EADTB exist (or soon will exist) for Army, Air Force and Marine systems. Also Joint BMC4I models are being developed by the services, the Joint National Test Facility (JNTF) and the Ballistic Missile Defense Office (BMDO). The Naval Air Engagement Model II (NAEM II) will be used in the study of interfaces to non-NTW systems where it provides unique capability. It is recommended that EADTB be used as the principal joint systems analysis tool for NTW with EADSIM II being used in a support/back up role.

2.7.3.2 Modeling and Simulation Data Requirements

There may be unique data required for the sensitivity analyses in Section 2.6.4. For EADTB, much of this is within the domain of the Specific System Representation (SSR) to be developed during the execution of this plan by specific NTW subject matter experts and will not require modifications to the force-on-force model. Exact data requirements have not been developed in this plan. However, work will be initiated at project start to further populate EADTB with the required subsystem level of SSRs for NTW.

2.7.4 Determine Key System Attributes

The step of determining the key system attributes will be based on:

- The NTW system attributes and success criteria;
- The Design Reference Mission; and
- The NTW Functional Description and critical interfaces.

Using the modeling strategy in Section 2.6.3, key system attributes and critical functions will be determined through analyses. The results of these analyses will be compiled into a Sensitivity Analysis Report documenting the attributes analyzed, the mapping of functions, the models and databases used and the results. This report will form the basis for developing the NTW Conceptual Performance Baseline. This methodology is shown in Figure 2-14.

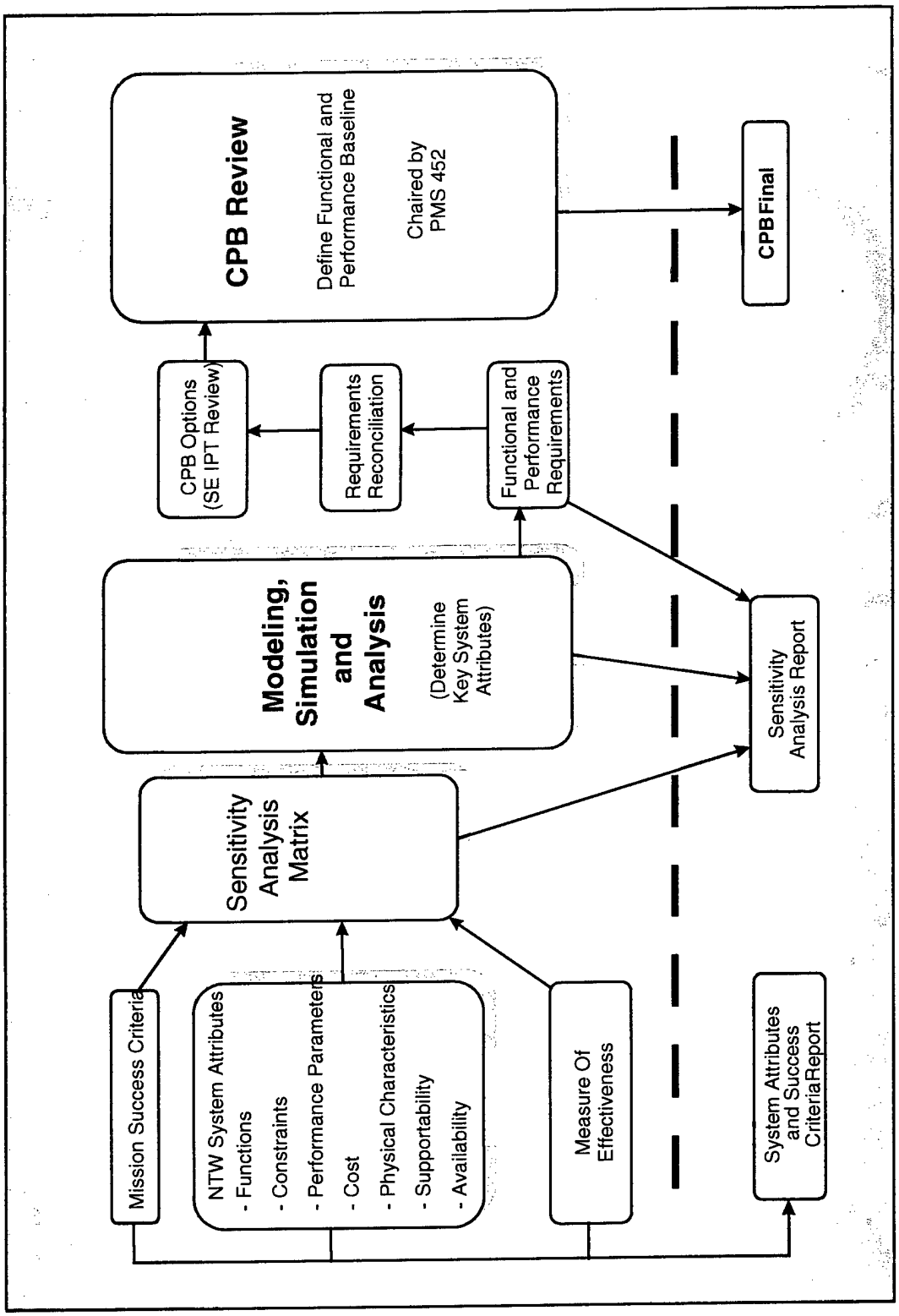


Figure 2-14. Methodology for Determining Key Attributes

2.7.4.1 Define Model Inputs

The NTW Mission Success Criteria, system attributes and MOEs developed in Section 2.6.2 will be used to develop a Sensitivity Analysis Matrix. This matrix will provide the inputs needed for the models in order to assess the sensitivity of system attributes with respect to high level functions. The Sensitivity Analysis Matrix will be documented as part of the Sensitivity Analysis Report.

2.7.4.2 Map NTW Functional Descriptions to Models

The NTW Functional Description prepared in Step 2 will be mapped to the system representation used in the analysis models. The objective of this mapping process is to clearly understand how each of the NTW functions is represented within the model. Many of these functions will be explicitly represented. However, many may be hidden in assumptions or represented implicitly within the model. Results of this exercise will be documented as part of the Sensitivity Analysis Report.

2.7.4.3 Perform Sensitivity Analysis

Selected models will provide sensitivity analyses based on the DRM and will be run in accordance with the Sensitivity Analysis Matrix and Functional Description mapping discussed above. Sufficient numbers of runs will be conducted to ensure result validity. Values will then be determined for the MOEs. These values will be scrutinized to determine and filter out the key system attributes including critical functions. For the most promising parameter sets evaluated, a corresponding rough order of magnitude life cycle cost estimate will be developed so that some measure of cost versus performance can be assessed. The process will be reiterated with adjustments made to the parameter set in order to obtain cost/performance sensitivities. The final result will be a process derived set of NTW functional and performance requirements within affordability constraints provided by the Operational Requirements Report generated in Step 0. More refined cost analyses will be completed in Step 4 and the iteration loop exercised again once the functional allocations have been made. Results of all analyses will be documented as part of the Sensitivity Analysis Report.

A wealth of data exists for NTW based on an exhaustive amount of analysis and trade studies which have been performed over the last 7 years. Interceptor kinematics, ship-based sensor detection range, space-based cueing time delays and accuracies, and discrimination have been examined and resultant operational/defended footprints developed over a wide variation of parameters. This analysis will make maximum utilization of all previous sensitivity studies, as well as the results from the Navy TBMD COEA Phase II. This effort will collect and collate these past efforts and build/extend only where needed to expand in the context of Joint TBMD mission area or for significantly new OPSITS or environments derived from the DRM.

2.7.5 NTW Conceptual Performance Baseline

Once the sensitivity analyses have been completed, several steps will still be required prior to finalizing the system level CPB. The derived functional and performance requirements must be reconciled with previously stated requirements determined from earlier steps in this plan. CPB options must be developed offering alternatives based on technical and warfighting risks. Finally, a Conceptual Performance Baseline Review (CPBR) will be held to review the CPB options and finalize the CPB.

2.7.5.1 Requirements Reconciliation

Requirements reconciliation will require an iterative process of comparing the derived functional and performance requirements with stated requirements defined in Step 0 and with the Functional Description developed in Step 2. In addition, significant variances between the required performance levels and the affordability constrained performance levels must be reconciled where they exist. Once these variances are reconciled, CPB options can be developed based on the remaining primary issues of risk and affordability.

2.7.5.2 CPB Options

Once the derived functional and performance requirements are reconciled, CPB options will be identified and will include verification methodology. A risk assessment will be performed specifying when certain warfighting capabilities are required along with the cost necessary to support those capabilities. Technical and warfighting risks will then be determined due to the impact of not having certain warfighting capabilities developed at certain times. Detailed risk management plans will not be developed at this time. The objective of the risk assessment is to determine if unacceptable warfighting risks are incurred with cost driven solutions or if alternative tactics might be employed to mitigate these risks. CPB options will be based on the risk assessment and will be ranked indicative of the likelihood of mission success by a consensus among Step 3 Work Group members.

2.7.5.3 Conceptual Performance Baseline Review and Documentation

CPB options will be reviewed with the Systems Engineering IPT to assist in finalizing recommendations for the CPB. A formal review of the recommendation, supporting data and rationale will then be conducted. The Conceptual Performance Baseline Review team will be led by PMS 452 and include selected personnel shown in Table 1-1. The CPBR will be coordinated by JHU/APL and NSWCDD.

The final CPB documentation will be modified, if necessary, based on the results of the CPBR. The CPB will include key system attributes associated with each critical functional, performance level required for each attribute, and acceptable cost goals. It will define the agreed upon functional, performance, cost and warfighting capability requirements for NTW. The CPB will be placed initially under interim configuration control upon approval by the Systems Engineering IPT and full configuration control after CPBR approval. Once the CPB is placed

under full configuration control, the Operational Requirements Traceability Matrix and Functional Description will be updated.

The CPB will form the basis for preliminary NTW SRD sections reflecting functional, performance and verification requirements. Also, the NTW Mission Program operational requirements updated by this step will be documented in preliminary sections of the SRD.

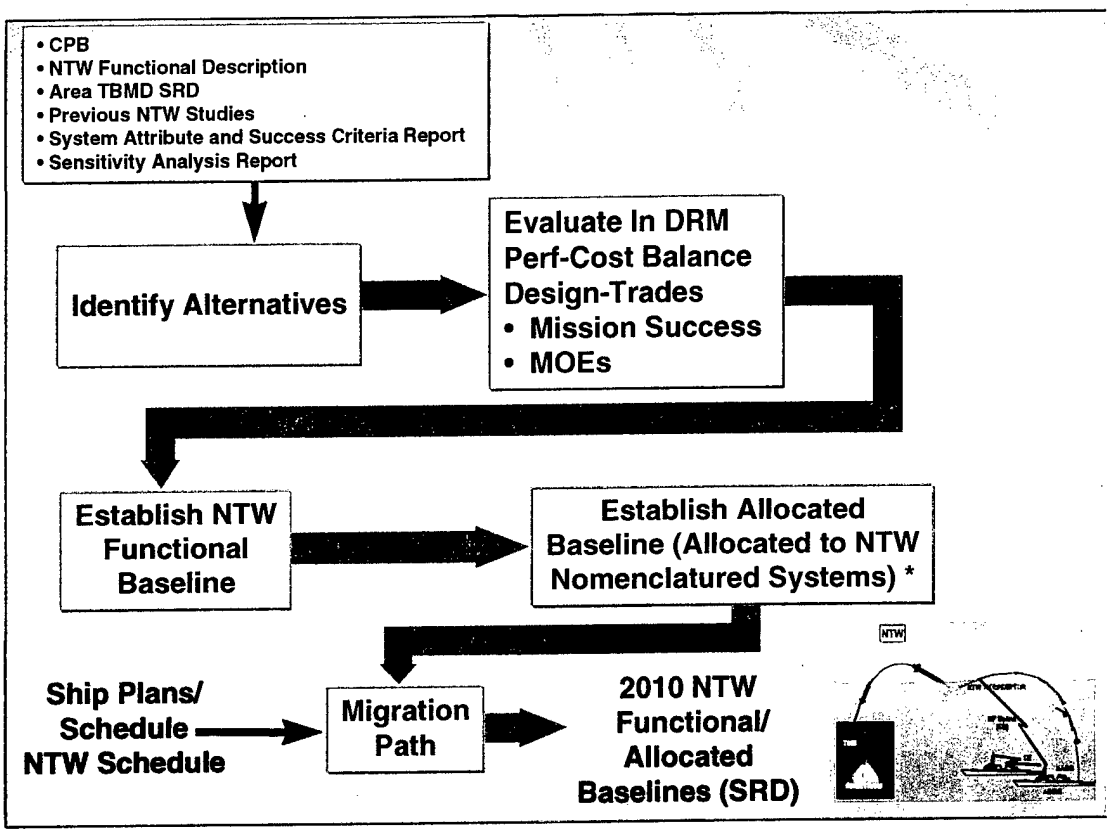
2.7.6 Step 3 Products

The following products will be produced by this step:

- NTW Conceptual Performance Baseline;
- Preliminary versions of the operational requirements, functional requirements, technical performance and verification requirements for the NTW SRD;
- NTW System Attribute and Success Criteria Report;
  - Mission Success Criteria;
  - System Attributes;
  - Measure Of Effectiveness;
- Sensitivity Analysis Report;
  - Sensitivity Analysis Matrix;
  - Key System Attributes; and
- Conceptual Performance Baseline Review documentation which will include the CPBR briefing package, action items and results.

2.8 STEP 4 – ESTABLISH THE FUNCTIONAL AND ALLOCATED NTW BASELINES

The purpose of this step in the process is to establish the FY2010 NTW Functional Baseline (performance, functional, physical) and allocate the baseline to existing and proposed subsystems. The migration plan to achieve the Allocated Baseline will also be defined in this step. See Figure 2-15.



* The Allocated Baseline in this case is documented in the SRD which the respective Program Offices will use to develop their combat system products.

Figure 2-15. Establish the Baseline

Figure 2-16 provides an overview of the system requirements engineering processes to be carried out in this step in a functional flow format. This step will identify the functions, key technical parameters and other attributes to be allocated to each of the core elements (nomenclatured subsystem) of NTW. This step also defines the interfaces and interoperability requirements between NTW and systems external to NTW.

This step will answer the following key questions:

- What are the system/subsystem alternatives for FY2010?
- What is the strategy for integrating any new elements included in these alternatives?

- What is the cost, risk, effectiveness and performance of the alternatives under consideration? Do they meet the Conceptual Performance Baseline, Top-level MOE and MSC defined in Step 3?
- Which of the alternatives provides the best balance between cost, risk, and effectiveness at the total system level?
- What is the migration path?
- What is the recommended allocation of functions, performance, effectiveness, cost, and other attributes to the NTW elements?

This step work group will be co-led by NSWCDD and JHU/APL with support from NTW element system engineers and others shown in Table 1-1.

2.8.1 Step 4 Inputs

As depicted in Figure 2-16, the major inputs to Step 4 are as follows:

- The Conceptual Performance Baseline - developed in Step 3;
- DRM - from Step 1;
- Sensitivity Analysis Report - developed in Step 3;
- Functional Descriptions and Functional Flow Diagrams - initially developed in Step 2 and updated after Step 3;
- Area TBMD System Requirements Document;
- Previous NTW Studies;
- Mission Success Criteria - from Step 3;
- MOEs from Step 3;
- COEA Scenarios/Results; and
- Existing Test Data.

2.8.2 Evaluation Approach

The basic evaluation approach to be used for this step is to:

1. Assess/validate how well alternative concepts meet the functional and performance requirements and other attributes in the Conceptual Performance Baseline that is developed in Step 3. This assessment will be done using individual simulations, test data for existing subsystems or other engineering analysis techniques as required. This effort will make maximum use of Navy TBMD COEA Phase II efforts, ALI lessons learned, risk reduction activities, and other Navy studies. Identification of the engineering models will be made from the existing NTW technical community M&S tool set after Step 3 has defined the Conceptual Performance Baseline. No significant modifications to the M&S tools currently available are anticipated for this system requirements engineering effort.

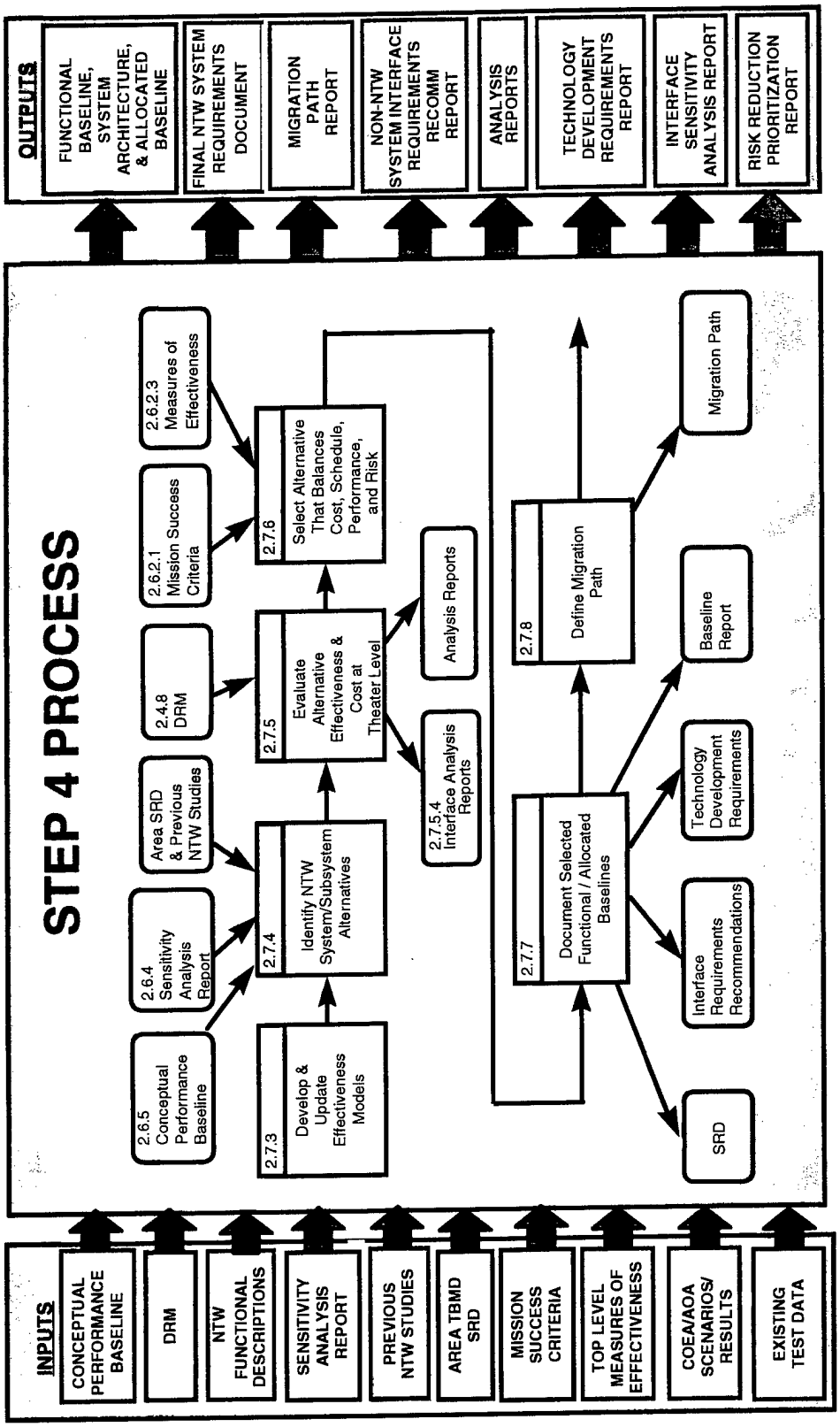


Figure 2-16. Baseline Establishment Process

2. Assess the performance and overall system effectiveness of alternative NTW concepts against the Mission Success Criteria and each of the top-level MOEs in Step 3.

3. Assess cost including life cycle cost for each of the alternatives being considered.

4. Perform effectiveness versus cost comparisons as part of the process of reaching a preferred system concept that balances cost, schedule and risk with performance. The DRM developed in Step 1 will provide the input operational situations for these evaluations.

In refining the modeling and simulation strategy for this step during the execution of this plan, the following questions will be addressed for both performance and cost modeling:

- Is modeling and simulation the most effective method to get answers?
- What exact questions do we expect to answer using M&S?
- Can the answers be extrapolated from previous analyses?
- What models and simulations are best suited to answer these questions within cost/schedule bounds?
- What are the limitations of the models being used?
- Are there modifications required? What are the modification costs?
- Are the answers a critical path to the system requirements engineering process? What is the backup plan if the model does not or can not get the answers?
- What are the associated risks in using the selected model? Are they acceptable?

2.8.3 Select and Update Performance and Effectiveness Models

The simulations and models from Step 3 will form the basis of the performance and effectiveness evaluations to be done in this step. These models will be evaluated to insure they have sufficient fidelity to represent the functionality and performance characteristics of the subsystems to be evaluated in the anticipated NTW alternatives. Where these models do not adequately support the effectiveness evaluations to be performed in this step other force-on-force models will be evaluated for use. Where force-on-force models are not adequate lower level models will be used. The models that will be considered for use in this step include:

Force-on-Force Models

EADTB
EADSIM
NABEM II

One-on-One

KIM
ADAM

High Fidelity Engineering Models

TRIPOD
FIRM TRACK
SEATRAP
MEDUSA
LDS
DEBRIS MODEL
SPECTRM
PEELS
PEGEM

2.8.4 Identify NTW System and Subsystem Alternatives

This substep identifies system alternatives to be considered for the NTW. To bound the scope of the quantitative performance, effectiveness and cost analysis that will be required, the development and assessment of alternatives will be done in two phases. The first phase will develop a set of potential alternatives with no specific limit on how many alternatives should be considered. This first set will then be assessed qualitatively to narrow the number of alternatives which will require extensive computer based performance analysis and detailed cost, risk, and schedule analysis in the second phase.

2.8.4.1 Propose NTW System Alternatives

The alternatives to be considered will encompass the full functionality of the NTW functional description defined previously in Step 2. The alternatives will be defined in terms of the functional and performance allocation to the individual NTW systems and elements. The development of alternatives will address full compliance with the Conceptual Performance Baseline developed in Step 3. Where achieving a desired level of performance is considered a potential cost driver, options will be developed for latter cost effectiveness analysis.

The alternatives to be developed will address:

- Functions not currently performed by existing systems but required to conduct Navy Theater Wide TBMD;
- Internal and external interface requirements; and
- Performance enhancements, new developments and innovations required to reach the desired level of NTW performance and effectiveness for the FY2010 time frame.

The development of alternatives will rely heavily on previous and ongoing NTW studies. In particular the ALI, NTW Block I and Navy TBMD COEA defined tactical configurations will be considered. Alternatives to be considered will include a range of sensor and missile options including:

- Modifications to the current SPY-1 Radar Signal Processor;
- The addition of a high power discriminating radar to be used in conjunction with the SPY-1;
- Next generation AEGIS Radar SPY-2;

- Targeting by joint sensors;
- LEAP;
- LEAP with optimum booster;
- Advanced Interceptor Technology (AIT) with new booster stack; and
- Advanced interceptors.

BMC^4I networks and systems to be addressed include:

- Exterior Communication System (EXCOM)(Including JMCOMS);
- Joint Tactical Information Distribution System (JTIDS/Link 16)- Joint Data Network (JDN);
- LINK-11;
- TRAP/TRE;
- Joint Maritime Command Information System (JMCIS) - Joint Planning Network (JPN);
- CEC - Joint Composite Tracking Network (JCTN);
- Shipboard AADC- Area Air Defense Commander; and the
- Tactical Data Distribution system (TDDS) - Replacement for TRAP/TRE.

In developing alternatives, consideration will be given to:

- Sensitivity to changes in external interfaces;
- Interoperability with other systems;
- Training and skills of operators;
- Ability of interface infrastructure to support throughput rate and timeliness; and
- Schedule, performance, and cost risks.

2.8.4.2 Select Alternatives for Detailed Cost and Effectiveness Analysis

Each proposed alternative will be:

- Validated against the operational requirements identified in Step 0;
- Validated against the updated functional requirements of Step 2;
- Validated against the performance baseline of Step 3. Options that have less than full performance but may result in a cost effective solution will be noted and carried forward for detailed cost effectiveness analysis;
- Assessed against the top-level MOEs including availability;
- Assessed as to ability to meet the mission critical requirements defined in Step 3;

- Assessed to determine system and subsystem sensitivity to (1) changes in interfacing systems and subsystems; (2) interface infrastructure capacities, accuracy and latencies and; (3) changes in threat;
- Assessed for inter-system compatibility and interoperability;
- Investigated to determine if current or near term technology supports the proposed subsystem concepts. Technology requirements will be compared to currently planned technology and functional road maps. Alternatives in which new technology investments would result in significant performance, cost, or functional payoffs will be identified and carried forward as options for the FY2010 time frame;
- Assessed as to cost and schedule risk;
- Assessed to determine if current RDT&E budgets support the alternative; and
- Assessed for training implications.

The above assessments and investigations will be engineering studies that will not require the use of force-on-force models and simulations that will be used in Section 2.7.7.

The system engineering tool used in Step 2 will be used to facilitate the validation of the proposed alternatives and insure functional completeness and traceability to requirements. This evaluation phase will not require the use of a force-on-force simulation model but will utilize engineering analysis, individual subsystem models and qualitative assessments to narrow the scope of alternatives to be rigorously analyzed in the final selection process.

A set of alternatives will be recommended for detailed performance, effectiveness, and cost analysis. This reduced set of alternatives should address a range of cost and performance. It is recognized that this set of alternatives may be similar to, and perhaps identical to, the interceptors currently under investigation by the Navy TBMD COEA Phase II. However, this analysis is necessary to complete the rigorous engineering process and tightly mapped to the Navy DRM and requirements flow-down.

2.8.5 Evaluate Alternatives Effectiveness and Cost

2.8.5.1 Assess the Effectiveness and Performance of the Proposed NTW Alternatives

The object of this substep is to quantitatively assess the performance and effectiveness of the alternative NTW concepts selected for further detailed analysis. These alternatives will be evaluated against the performance baseline developed in Step 3 and evaluated to determine how effectively these alternatives perform in the context of the FY2010 Design Reference Mission defined in the previous steps. Each alternative will be assessed to determine it's capability in terms of the overall top-level NTW MOEs defined in Step 3.

The simulation models identified in Section 2.7.3 will be the basis for the evaluation of alternative NTW effectiveness. NTW performance and effectiveness will be evaluated for each of the operational situations called out in the DRM. The results from each operational situation will be weighted and combined to produce a quantitative determination of how well the NTW System concept meets the top-level MOEs and MSC.

2.8.5.2 Perform Cost Analysis of Alternatives

Detailed total life cost analysis will be performed for each NTW alternative under consideration. Cost analysis will be performed by an IPT that includes the pertinent element systems engineers, logisticians, Navy cost analysts and core NTW personnel. Costs risks will be identified and key NTW cost drivers will be identified and used for possible revisions to the alternatives under considered. Specific ground rules that shall apply to the cost analysis are as follows:

- Costs to be included:
  - RDT&E for ongoing and near term improvements and enhancements
  - SCN costs for future installations;
  - Other procurement costs, i.e., OPN, WPN, for planned future installations and upgrades;
  - Projected 20 year O&S costs;
  - Installation costs not in SCN and RDT&E budgets;
  - Impact on ship cost;
- All costs to be given in FY98 dollars;
- Inflation indices and outlay profiles will be identified and agreed to at time of plan execution;
- For subsystems that have significant non-NTW functionality the costs shall be prorated between NTW and the other virtual high level system; and
- Maximum utilization of the cost analysis results and methodology employed on the Navy TBMD COEA Phase II will be used.

This effort will also identify the development, production, and operations and support cost drivers and issues. An assessment of the adequacy of current budget lines to support planned upgrades, acquisitions and support will be made and shortfalls identified. Areas for possible cost savings will be noted.

2.8.5.3 Assess Risks Associated with Each of the Alternatives

Each alternative will be assessed for technical, cost and schedule risk. Specific risk areas will be identified and risk monitoring and recommendations for risk management procedures for use in latter development phases will be made.

2.8.5.4 Analyze Interface Sensitivity of Each Alternative

This substep will build on the interface analysis done in Step 2. Internal and external interface performance requirements that stress or significantly impact system performance such as data link reporting latency will be identified and documented. The accuracy and timeliness performance of external system interfaces will be analyzed for impact on overall NTW effectiveness and performance.

2.8.6 Select Alternatives that Balance Performance, Cost, Schedule, and Risk

The overall objective of the NTW system requirements engineering process is to define an FY2010 baseline that balances cost, effectiveness, and risk. This baseline must be affordable, within the scope of current budget projections and must be programatically achievable within the time constraints. The cost effectiveness comparisons will be done for a 20 year life cycle . The following features of each alternative will be ranked and compared against the total NTW life cycle costs:

- Top-level MOEs;
- Performance against Mission Success Criteria;
- Support of individual subsystem and higher level ORDs;
- Support of Conceptual Performance Baseline of Step 3;
- Risk;
  - Overall development risk assessment
  - Ability of subsystems to achieve allocated performance requirements
  - Schedule
  - Availability of required technology
- Time to earliest feasible IOC for the nomenclatured systems comprising the alternative; and
- Sensitivity to changes in other subsystems.

An IPT comprised of NSWCDD, JHU/APL and effected program systems engineers will be utilized in this effort.

2.8.7 Document Selected Functional and Allocated Baselines

The recommended alternative will be documented in a Baseline Report that contains the following:

- Allocation of functions, performance requirements, and other attributes to subsystems, (e.g., nomenclatured subsystems);
- NTW system functional architecture and tiered functional flow diagrams;
- External and internal system and subsystem interface descriptions;
- Traceability of performance and functional requirements to:
  - The Conceptual Performance Baseline
  - Top-level MOEs
  - Operational Requirements
  - Mission success criteria

- Integration strategy;
- Required interface and interoperability standards; and
- Selection rationale including cost, schedule, risk and performance.

This baseline report will form the basis of the NTW System Requirements Document. The SRD will define functional, interface, performance and verification requirements at the mission, at the mission program, and at the individual element levels. In addition, a Technology Development Requirements Report, Risk Reduction Prioritization Report and a non-NTW Systems Interface Requirements Report will be written. The Technology Development Requirements Report will detail the required technology efforts needed to support the evolution to the FY2010 capability along with estimates of required funding and schedules for these efforts. The Risk Reduction Prioritization Report will recommend risk reduction efforts that should be performed in support of the development of the recommended NTW baseline. The non-NTW systems interface requirements recommendations will document improvements in systems external to NTW that are required to support the recommended NTW alternative or that provide cost effective enhancements to overall NTW performance and effectiveness.

2.8.8 Define Migration Path

A plan of actions required to reach the NTW FY2010 baseline will be developed. That plan will include the following:

- Phased development plan that addresses the evolution of the current AEGIS Combat System FY2010 baseline;
- Top-level schedules and budget estimates for each required improvement and new development;
- Assessment of current RDT&E budgets to support the evolution to the FY2010 baseline;
- Top-level ship integration plan; and
- POM inputs to implement migration path.

2.8.9 Step 4 Products

The following products will be produced by this step:

- Baseline Report (Functional Baseline, System Architecture, and NTW Allocated Baseline);
- Final NTW System Requirements Document;
- Migration Path Report;
- Non-NTW Systems Interface Requirements Recommendations Report;
- Analysis Reports;

- Technology Developments Requirements Report;
- Interface Sensitivity Analysis Report; and a
- Risk Reduction Prioritization Report.

2.9 STEP 5 – CONDUCT MISSION SYSTEM REQUIREMENTS REVIEW (MSRR) FOR NTW

The Navy Theater Wide TBMD systems requirements engineering process culminates with the MSRR during which the NTW Allocated Baselines (documented in the SRD), migration path, non-NTW interface requirements recommendations, technology development requirements and supporting analysis reports are presented to the Navy's senior leadership for concurrence, transition to Program Managers (PMs) for execution and POM planning input.

The purpose of this step is to obtain approval of the NTW Allocated Baseline developmental requirements in the SRD. The MSRR presents the objectives and the allocation of these requirements to both systems/subsystems and external interfaces. The intent of this review is to obtain approval of the recommended NTW baseline and the proposed migration path. Recommended adjustments to both new and existing developments are provided for redirection of the present design processes and POM planning input. The results of this process will be updated and reviewed to incorporate lessons learned, evolving technology and new requirements as part of the broader Surface Navy Theater Air Defense systems requirements engineering process.

The process for conducting the MSRR for NTW, follows the same system requirements engineering model used throughout this plan in which inputs are identified and processes are designed to achieve a desired output. Figure 2-17 shows this process and the composition of each of its components. Each of these components for executing the NTW is discussed in the following subsections.

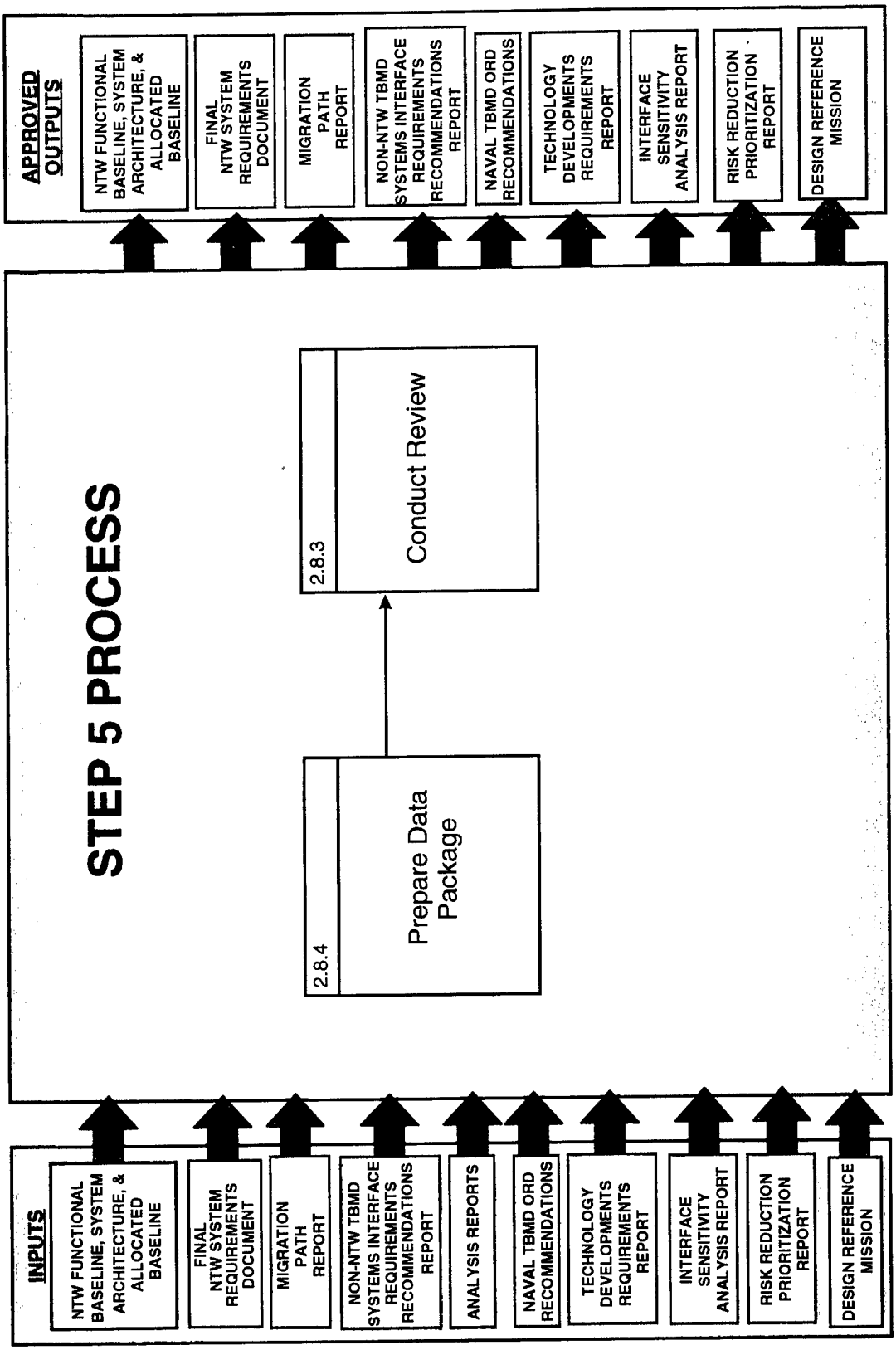


Figure 2-17. MSRR Execution Process

2.9.1 MSRR for NTW Objectives

As stated above, the MSRR provides a forum for presenting the results of the NTW system requirements engineering process to the Navy's senior uniformed and civilian leadership for concurrence and approval of the NTW baseline, POM planning input and approval for transition to respective program managers for execution. These objectives as well as an approved NTW SRD and concurrence on non-NTW requirements recommendations are the desired outputs of the NTW MSRR.

2.9.2 Participants

The PMS 452 shall lead the NTW MSRR with support from JHU/APL and NSWCDD with participants as identified in Table 1-1.

2.9.3 Step 5 Inputs

The Step 5 inputs are shown in Figure 2-17.

2.9.4 Material to be Presented

The material to be presented represents the products of the NTW system requirements engineering process. The material to be presented will be the supporting NTW system requirements engineering products and findings and will include:

- The recommended NTW baseline requirements;
- Final NTW System Requirements Document;
- Alternatives considered;
- Selection rationale;
- The migration path to achieve the NTW Allocated Baseline;
- Non-NTW Systems Interface Requirements Recommendations Report;
- Technology development requirements;
- Interface Sensitivity Analysis Report;
- Key analysis results as necessary; and
- Risk Reduction Prioritization Report.

2.9.5 Data Package

The supporting NTW system requirements engineering products and findings which substantiate the recommended NTW system design will be compiled into a data package for

presentation and referenced at the NTW MSRR. The data package will consist of the following the products:

- NTW System Requirements Document (Includes: top-level performance requirements, functional and performance allocations for each element including the key functional interface requirements and functional architecture);
- Functional flow diagrams;
- Functional descriptions at the NTW and element levels;
- Analysis and simulation data;
- Draft recommendations of modifications and additions to the Naval TBMD ORD;
- Recommended interface standards;
- Recommended interoperability standards;
- Non-NTW System Interface Requirements Report;
- Risk Reduction Prioritization Report; and a
- Design Reference Mission.

2.9.6 Step 5 Products

The outputs and products of Step 5 are the approved inputs of this system requirement engineering effort. The Naval TBMD ORD recommendations will be passed to CNO N86 for consideration. The other output products will be passed to cognizant program managers for execution.

SECTION 3.0 – WORK BREAKDOWN STRUCTURE

This section provides the Work Breakdown Structure (WBS) and the detailed schedule for executing the plan for Navy Theater Wide TBM system requirements activities.

3.1 WORK BREAKDOWN STRUCTURE

The Work Breakdown Structure for executing NTW system requirements engineering is provided in Figure 3-1.

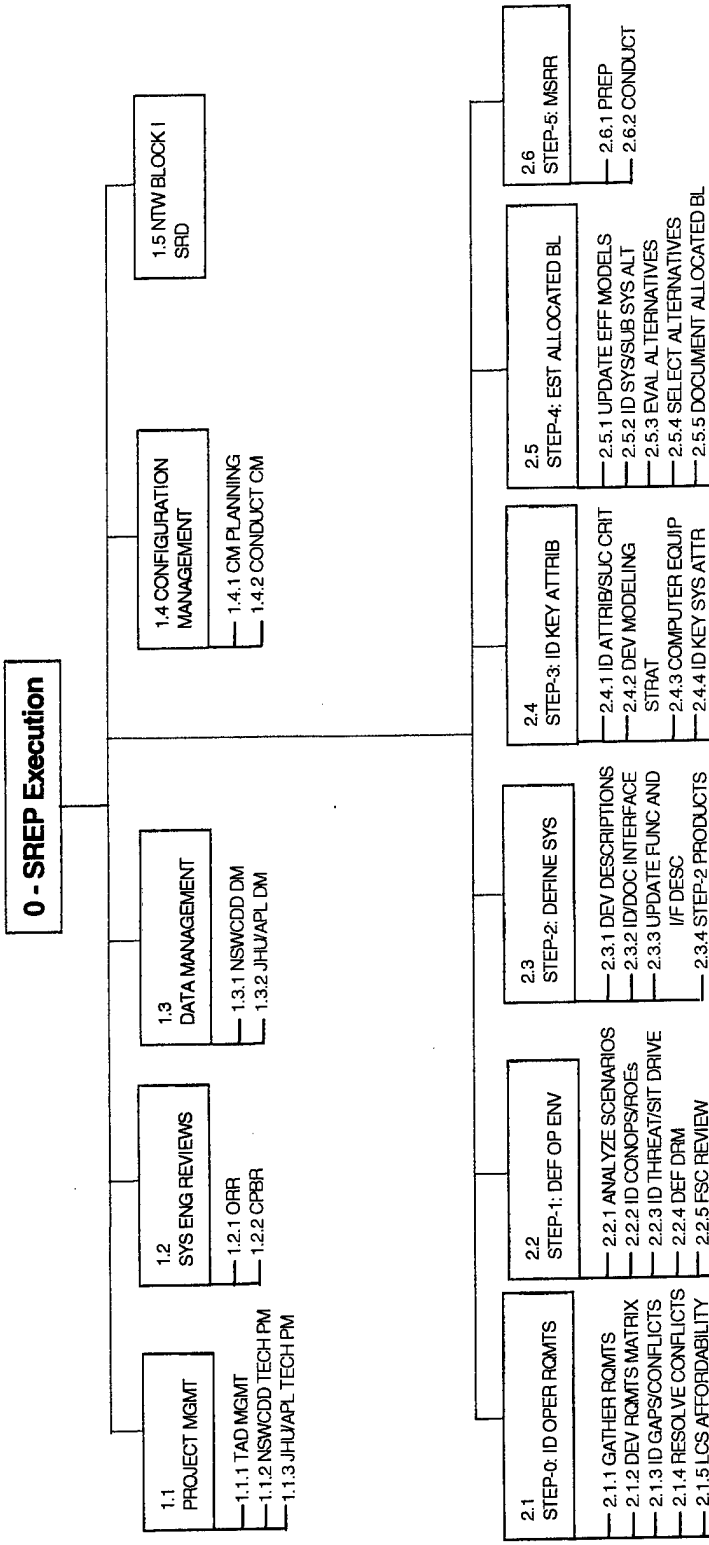


Figure 3-1. NTW SREP WBS

APPENDIX A

ACRONYMS AND ABBREVIATIONS

ACRONYMS AND ABBREVIATIONS

AADC	Area Air Defense Commander
ACS	AEGIS Combat System
AIT	Advanced Interceptor Technology
ALI	AEGIS LEAP Intercept
ASMD	Anti Ship Missile Defense
ASN	Assistant Secretary of the Navy
ASR	Alternative Systems Review
AWS	AEGIS Weapon System
BMC^4I	Battle Management Command, Control, Communications, Computers and Intelligence
BMDO	Ballistic Missile Defense Office
C^4I	Command, Control, Communications, Computers and Intelligence
CARD	Cost Analysis Requirements Description
CDR	Critical Design Review
CEC	Cooperative Engagement Capability
CM	Configuration Management
CMD	Cruise Missile Defense
CNO	Chief of Naval Operations
COEA	Cost and Operational Effectiveness Analysis
CONOP	Concept of Operations
CPB	Conceptual Performance Baseline
CPBR	Conceptual Performance Baseline Review
CRD	Capstone Requirements Document
CSSE	Chief Ship Systems Engineer
CTV	Control Test Vehicle
CWSE	Chief Warfare Systems Engineer
DAB	Defense Acquisition Board
DIA	Defense Intelligence Agency
DPG	Defense Planning Guidance
DOD	Department of Defense
DRM	Design Reference Mission
DSP	Defense Support Program
EADSIM	Extended Air Defense Simulation
EADTB	Extended Air Defense Test Bed
EXCOM	Exterior Communication System
FCA	Functional Configuration Audit
FUE	First Unit Equipped

ACRONYMS AND ABBREVIATIONS (Continued)

GCCS	Global Command and Control System
GPS	Global Positioning System
GTV	Guided Test Vehicle
IPPT	Integrated Product/Process Improvement
IPT	Integrated Product Team
JCTN	Joint Composite Training Network
JDN	Joint Data Network
JHU/APL	Johns Hopkins University/Applied Physics Laboratory
JMCIS	Joint Maritime Command Information System
JMCOMS	Joint Maritime Communications
JNTF	Joint National Test Facility
JPN	Joint Planning Network
JROC	Joint Requirements Oversight Committee
JTAMDO	Joint Theater Air Missile Defense Office
JTIDS	Joint Tactical Information Distribution System
KW	Kinetic Warhead
LCC	Life Cycle Cost
LEAP	Lightweight Exo-Atmospheric Projectile
M&S	Modeling and Simulation
MIT/LL	Massachusetts Institute of Technology / Lincoln Laboratory
MNS	Mission Needs Statement
MOEs	Measures of Effectiveness
MSC	Mission Success Criteria
MSRR	Mission System Requirements Review
N4	Deputy Chief of Naval Operations (Logistics)
N6	OPNAV Director, Space Information Warfare Command and Control
N865	OPNAV Director Theater Air Warfare
NAEM	Naval Air Engagement Model
NAVSEA	Naval Sea Systems Command
NRL	Naval Research Laboratory
NSWC	Naval Surface Warfare Center
NSWCDD	Naval Surface Warfare Center - Dahlgren Division
NTW	Navy Theater Wide Theater Ballistic Missile Defense
O&S	Operations and Support
OPN	Operations Procurement Navy
OPNAV	Office of Chief of Naval Operations
OPSIT	Operational Situations

ACRONYMS AND ABBREVIATIONS (Continued)

ORD	Operational Requirements Document
ORR	Operational Requirements Review
PCA	Physical Configuration Audit
PEO	Program Executive Officer
PEO SC	Program Executive Officer, Surface Combatants
PEO(TAD)	Program Executive Officer, Theater Air Defense
PEO(TAD)-SE	Program Executive Officer, Theater Air Defense Systems Engineering
PDR	Preliminary Design Review
PM	Program Manager
POM	Program Objectives Memorandum
RDT&E	Research Development Test and Evaluation
ROE	Rules of Engagement
RRA	Risk Reduction Activities
SBIRS	Space Based Infrared System
SCN	Shipbuilding and Construction Navy
SE	Systems Engineering
SE IPT	Systems Engineering Integrated Product Team
SECNAV	Office of Secretary of the Navy
SE IPT	Systems Engineering IPT
SEP	Systems Engineering Plan
SEM	Systems Engineering Memorandum
SEMP	Systems Engineering Management Plan
SETAT	Systems Engineering Technical Assessment Team
SFR	System Functional Review
SMTS	Space Missile Tracking System
SPAWAR	Naval Space Warfare Command
SRD	System Requirements Document
SRR	Software Requirements Review
SSR	Specific System Representation (EADTB)
SSR	Software Specification Review
STAR	System Threat Assessment Report
T&E	Test and Evaluation
TAD	Theater Air Defense
TBM	Theater Ballistic Missile
TBMD	Theater Ballistic Missile Defense
TDDS	Tactical Data Distribution System
TFCC	Tactical Flag Communications Center
THADD	Theater High Altitude Air Defense
TIBS	Tactical Information Broadcast System
TIMS	TFCC Information Management System

ACRONYMS AND ABBREVIATIONS (Continued)

TLR	Top Level Requirement
TMD	Theater Missile Defense
TRR	Test Readiness Review
UOES	User Operational Evaluation System
VLS	Vertical Launching System
WBS	Work Breakdown Structure
WPN	Weapons Procurement Navy

APPENDIX B

DELIVERABLES

DELIVERABLES

The following list shows the deliverables required by this plan:

1. System Requirements Document (SRD) Deliverables	Due Upon Completion					
	Step 0	Step 1	Step 2	Step 3	Step 4	Step 5
Scope of the System			Initial Draft		Final	
Threats and Environment	Initial Draft	Preliminary			Final	
Operational Requirements	Initial Draft			Preliminary	Final	
Functional Requirements			Initial Draft	Preliminary	Final	
Technical Performance / MOEs				Preliminary	Final	
Allocated Functionality / Performance					Final	
Interface Requirements			Initial Draft		Final	
Verification Requirements				Preliminary	Final	
Final SRD					Final	
Approved SRD						X

DUE AT:

2. STEP E

2. E-1 Draft Recommendation for the Naval TBMD ORD — Completion of Step

2. E-2 Operational Requirements Report — Completion of Step

DELIVERABLES (Continued)

3. STEP F	DUE AT:
3. F-1 Design Reference Mission (DRM)	Completion of Step
3. F-2 Analysis Report	Completion of Step
4. STEP G	
4. G-1 NTW Hierarchical Functional Descriptions	Completion of Step
4. G-2 NTW Interoperability Requirements	Completion of Step
4. G-3 NTW Interface Description and Functional Flow Diagrams	Completion of Step
5. STEP H	
5. H-1 NTW Conceptual Performance Baseline	Completion of Step
5. H-2 NTW System Attribute and Success Criteria Report	Completion of Step
5. H-3 NTW Sensitivity Analysis Report	Completion of Step
6. STEP J	
6. J-1 Baseline Report (Functional Baseline, System Architecture and NTW Allocated Baseline)	Completion of Step
6. J-2 Migration Path Report	Completion of Step
6. J-3 Non-NTW Systems Interface Requirements Recommendations Report	Completion of Step
6. J-4 Technology Developments Requirements Report	Completion of Step
6. J-5 Interface Sensitivity Analysis Report	Completion of Step

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